THE MECHANIC ARTS MAGAZINE

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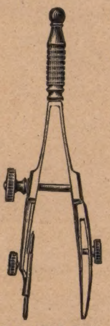

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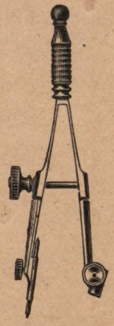

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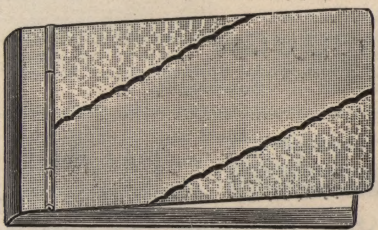

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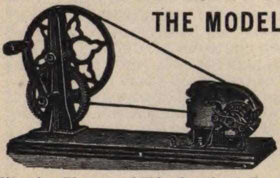

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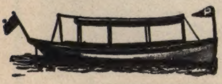

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THE MECHANIC ARTS MAGAZINE.

Vol. IV. JULY, 1899. No. 6.

SPLICES, KNOTS, AND BENDS.

Ernest K. Roden, Captain of Sail and Steam.

THE A B C OF THE ART OF ROPE SPLICING—HOW TO USE THE MARLINESPIKE—KNOTS, BENDS, AND HITCHES THAT ARE USEFUL IN THE WORKSHOP.

HOWEVER useful it may be to those immediately concerned, it cannot be said that the operation of splicing together two pieces of hemp rope is in itself particularly attractive or interesting, and it is more than possible that the reader will feel that his occupation, business, or profession is never likely to call for any knowledge of the art. Nevertheless, at some future time he *may* be brought unexpectedly face to face with an emergency where the ability to make a good durable splice or to tie a strong reliable knot will come in very handy, so it may not be entirely waste of time for him to read on. Moreover, it is probable that among the thousands who read this magazine every month, there are many who are more or less interested in yachting and shipping, or are employed in workshops where rope splices and rope tackle are not altogether unknown; to such the writer feels that a few practical hints from one who knows about these things will be of real value.

FIG. 1.—USING THE MARLINESPIKE.

To begin with, let us define the word "splicing." Splicing is the operation of joining two pieces of rope so as to obtain one continuous piece, with no appreciable increase of diameter at the splice.

There are several kinds of splices, but the two principal ones are the *short* splice and the *long* splice; these will be described first. Among other forms is the *eye* splice; this, and a variety of knots, bends, and hitches, will be taken up afterwards.

The principle of all splicing consists of joining, or "marrying," the strands, thinning them out, and tapering them, so that the diameter at the splice is the same or only slightly greater than that of the rope itself. In the long splice, no increase in diameter is allowed.

Until within comparatively recent years, all ropes were made of vegetable fiber teased out and spun into suitable form either by hand or machinery; but since the introduction into the rope-manufacturing industry of iron, and particularly of mild steel, steel rope is rapidly superseding all other kinds, even for running gears. For many purposes, however, fiber ropes are still used and can never be replaced by steel ones; they are made, for the most part, of either hemp, manila, or coir (cocoanut husk fiber).

First, the fibers are spun into yarns, then the yarns into strands, and finally the strands into rope. The methods of splicing described and illustrated here apply only to these fiber ropes.

The only instruments necessary for making a splice are a marlinespike and a knife. The former is made of either iron or hard wood, is from 12 to 14 inches long, and about 1 inch in diameter at the thick end, the other end being sharpened to a blunt point about as shown in Fig. 1; it is always operated by the right hand, while the left encircles the rope. After pushing the extreme point through between the strands to be separated, the thick end is placed against the body of the operator; then, using both hands, the rope is twisted so as to render the work of opening the strands comparatively easy.

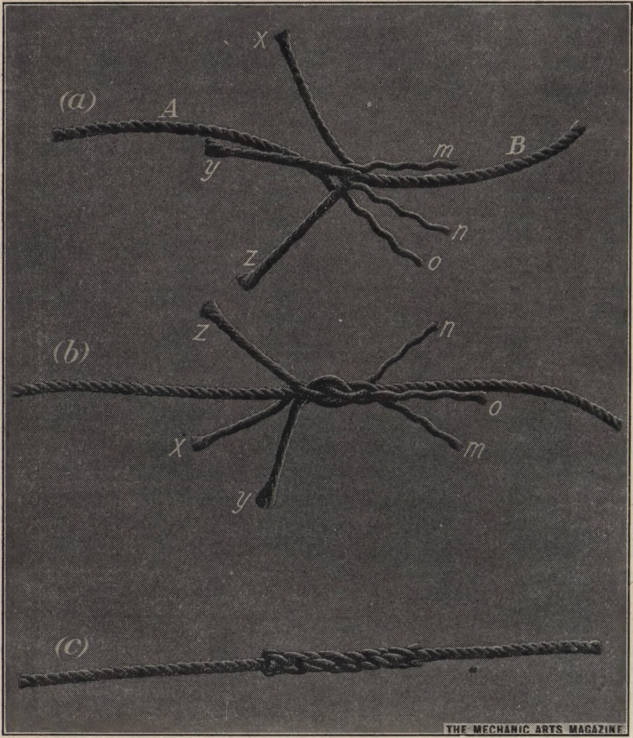

FIG. 2.—THE SHORT SPLICE.

To make a short splice: Unlay—that is, split open—the strands at the end of each rope for a distance about as shown in Fig. 2; this distance depends entirely upon the diameter of the rope, but as the proportion will be the same for all diameters, the illustration serves as a general guide; be sure to unlay enough; a few inches too much is better than too little, as the ends have to be cut off anyway. Then, place the two ends together, as shown at (*a*), Fig. 2, so that each strand lies between two strands of the other rope. Now, hold the strands *x y z* and the rope *A* in your left hand; if the ropes are too large to hold thus, fasten them together with twine; then take one of the strands, say *n*, pass it over strand *y*, and, having made an opening, either with the thumb or with a marlinespike, in the manner illustrated in Fig. 1, push this strand *n* through under *x* and pull it taut; this operation is known as "sticking." Proceed similarly with strands *m* and *o*, passing each over the immediately adjoining strand and under the next one. Perform precisely the same operation with the strands of the other rope, passing each strand over the adjoining one and under the next, thus making the splice appear as at (*b*), Fig. 2. Now, in order to insure security and strength, this work must be repeated by passing each strand over the third and through under the fourth, then, after subjecting the splice to a good stout pull, cut off the ends of the strands, and you have the finished splice as shown at (*c*), Fig. 2.

In slings and straps used for heavy work, the strands should be passed twice each way, and one-half of each strand should be "whipped," or bound, with twine to one-half of the rest, thus preventing the strands from "creeping through" when the splice is taxed to the full capacity of the rope.

In the short splice, the diameter at the join is rather greater than that of the rope, for which reason it is not a suitable splice where the rope is to be used in tackles and pulley blocks, or in places that will not admit anything larger than the rope itself. In such cases the long splice is used; this, when properly made, the untrained eye can hardly distinguish from the rest of the rope. To make the long splice: Unlay the ends as before, but about three times as far, and

place them together, as shown at (a), Fig. 3, in the same manner as for the short splice. Then unlay one of the strands, say x of the right-hand rope, and in the groove thus made lay the strand n of the left-hand rope, taking good care to give this strand the proper twist, so that it falls gracefully into the groove previously occupied by strand x. Do likewise with strands y and m, unlaying y gradually and in its place laying the strand m; the result is shown at (b) Fig. 3. Now,. leaving the middle strands p and g in their original positions, cut off all the strands, as shown at (b); then relieve strands n and x of about one-third of their yarns, and with what splice compares with the rope in strength and durability; in other words, is the splice as strong as the rope that it joins? In the opinion of the writer, it is; the splice is quite as strong and durable as the rope itself. This is proved by the fact that on shipboard it is very rarely one hears of a rope or sling snapping in the splice. When such a thing does occur it is generally easy to trace the origin of the splice to some "greenhorn" of a sailor, or, if on a steamer, to some member of the engine department who parted with his teacher in rope splicing a little too soon. However, the *theoretical* version of the matter is that the splice is about one-eighth weaker than the rope itself; this is on the safe side,

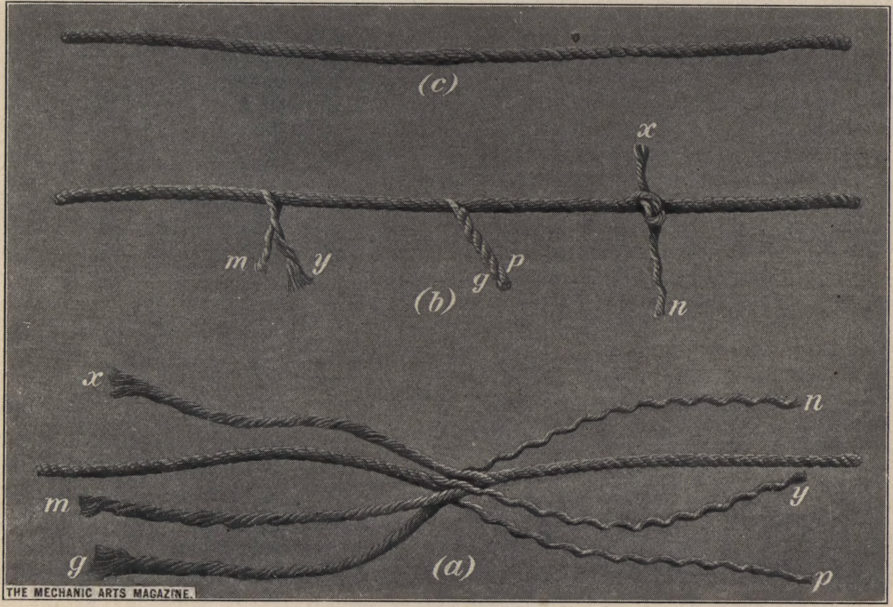

FIG. 3.—THE LONG SPLICE.

is left cast an overhand knot as shown —exactly as shown; no other kind of knot will do. Pull this knot taut and dispose of the ends as in the short splice, by passing them over the adjoining strand and through under the next, cutting off a few yarns at each "stick." Proceed similarly with strands p and g, and y and m. The splice, when it is completed, appears as at (c), Fig. 3. Sometimes the overhand knot is made without first thinning the strands, and then split and the half strand put through as described, but by doing so, the surface of the splice is never as smooth as by the other method, which, for strength and neatness, is second to none.

A question frequently asked is how the

and makes allowance for indifferent work.

Another splice, and one that is as common and useful as the two already described, is the *eye* splice, illustrated in Fig. 6. To begin this, unlay the end of the rope about as far as for the short splice, and bend into the required size of eye, as shown at (a). Then tuck the end of the middle strand y under one of the strands of the standing part—having previously made the necessary opening with the marlinespike—and pull tight, getting what is shown at (b). Now push the strand x from behind, and under the strand on the standing part next above that under which the middle strand y was passed, so that it will come out where y went in, getting

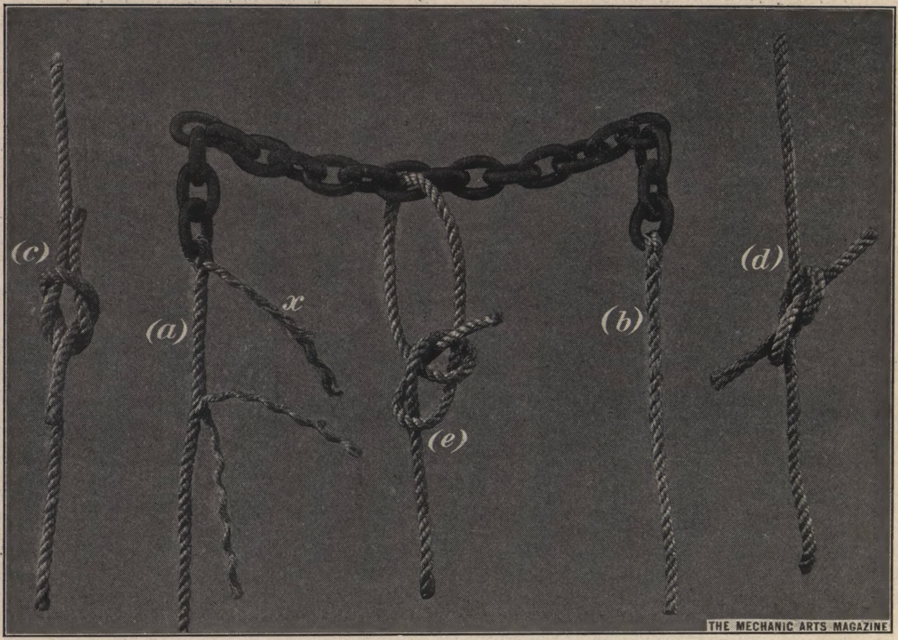

FIG. 4.—THE OVERHAND AND THE BOWLINE KNOT, AND A USEFUL SPLICE.

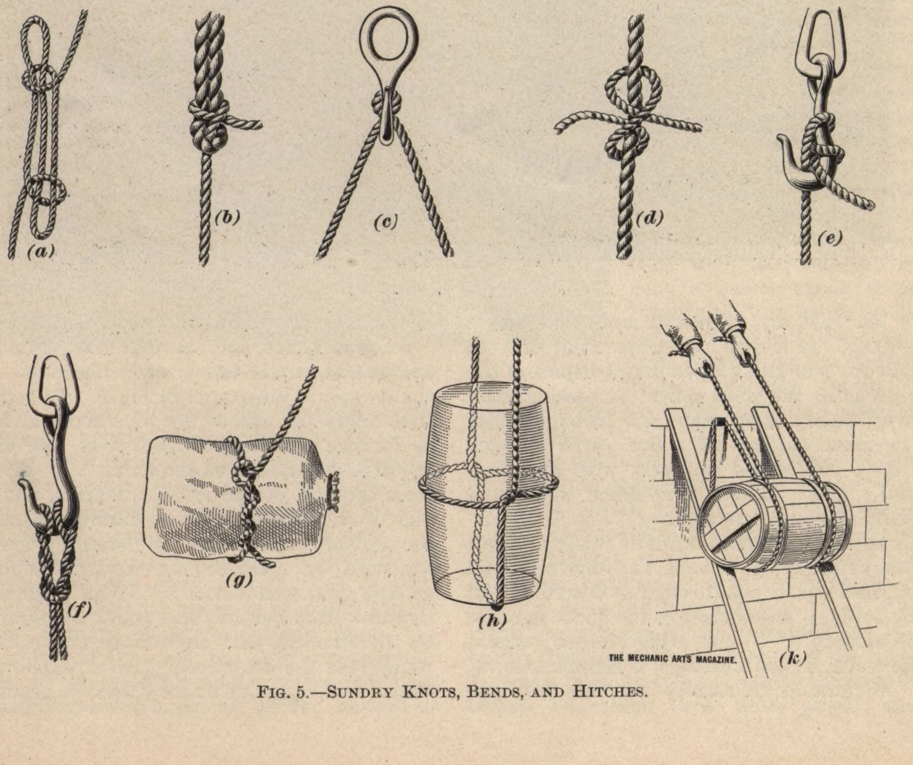

FIG. 5.—SUNDRY KNOTS, BENDS, AND HITCHES.

what is shown at (c); then pass the third strand z under the remaining free strand in the standing part, next to the one under which y was passed, getting (d). Now pull the strands taut, and from each cut out one-third of the yarns; pass each one over the adjoining strand and then through under the next, as in the short splice; then cut out one-half of the yarns, and tuck each one under its corresponding strand for the third time; give it a good stretching, cut off the ends, and thus complete the splice as shown at (e).

These three splices, the short, the long, and the eye, may justly be termed the A B C of the art, for if they are once thoroughly mastered the making of others becomes of little difficulty, since all other forms and varieties are in general but modifications or applications of them.

In Fig. 4, (a) and (b) show how to splice a small rope to a chain. To make this splice: Unlay the strands of the rope and reeve two of them through the end link; then unlay the third strand for about the distance shown, and in its place lay one of the other strands, the same as in making the long splice; make an overhand knot and dispose of the ends in the usual way; dispose of the third strand x—one of the two reeved through the link—as when making the eye splice, by "sticking" near the link; cut off the ends, and the splice is complete as shown at (b), Fig. 4. This is a very neat and strong splice, and can be used with advantage in connection with chains that are "tailed," or lengthened, with a rope that has to pass through sheaves or places that do not allow any increase of diameter in the rope.

Having made the reader acquainted with the principal splices in existence, it will, perhaps, not be out of the way to add a few words about the making of sundry bends and hitches connected with the handling of cordage. Among landsmen in general and persons not familiar with the use of ropes, the ignorance displayed in this direction is astonishing, there being very few indeed who know even how to knot two pieces of rope together properly. Nine persons out of ten will make the knot as at (d), Fig. 4. And why? Simply because of that everlasting human instinct to commit error, by which we are all affected more or less. Such a knot hardly amounts to anything, as the least pull will cause it to slip. At (c), in the same illustration, the correct way to make the knot is shown.

Fig. 6.—The Eye Splice.

Another error is indicated at b in Fig. 7; this is frequently committed by amateur yachtsmen when belaying or securing a rope—say the sheet of a sail—to a cleat. If, during a cruise, the boat is caught in a sudden squall that demands the immediate slacking up of the sheet, the result of this method of fastening it is more likely than not to prove fatal to the occupants of the boat, by causing immediate capsizing. As

will at once be understood by a glance at the illustration, the increased strain on the sheet in such a case will jam the rope and render it impossible to ease off the sheet. Of the many cases of boats capsizing, most are due to this way of belaying the sheet. At *a*, Fig. 7, is shown the correct way to secure the rope.

A very useful knot that should be mastered by every mechanic and by all persons in any way connected with shipping is shown at (*e*), Fig. 4; by seamen this is known as the *bowline* knot. To make it, take the end of the rope in the right hand and the standing part in the left, and lay the end over the standing part. Then, with the left hand, turn over the end a *bight* (a loop, or turn) in the standing part, pass the end over and around the standing part, and through the bight again, thus completing the knot; all this is shown with perfect clearness in the illustration.

As an example of the many uses to which in emergencies the bowline knot can be applied, the following report found in the news columns of one of the New York dailies will perhaps be interesting: "At about half-past four o'clock this morning a patrolman on duty near pier No. 15, East River, was attracted by distressing cries for help that apparently came from the water-front. He hastened toward the end of the pier, and through the haze overhanging the water made out a human being struggling against the tide, which was slowly carrying him down toward the bay. The officer, quickly realizing that the drowning man was too far from the pier to be reached by an ordinary boathook, jumped down to the deck of a lighter that lay alongside the pier and getting hold of a rope made in the end of it a *bowline knot* large enough to admit the body of a man; this he threw out to the nearly exhausted struggler, shouting to him not to try to hold on to the rope but to get the loop over his head and under both his arms. The man finally succeeded in doing this, the line being paid out as he drifted away, and the officer, feeling that the rope had a good hold, began to haul in, and with the assistance of a brother officer who had responded to his call, the drowning man, now almost unconscious, was lifted on to the deck of the lighter. Here he soon revived and was able to give his name and also the name of the vessel from which he fell into the river. The policeman attributed the saving of this man's life solely to the bowline knot, as the man was too weak to have held on with his hands until the deck had been reached."

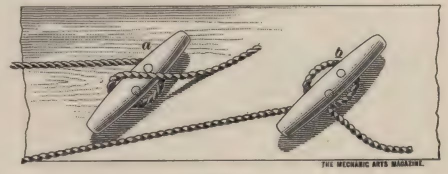

FIG. 7.

In Fig. 5 are illustrated a few methods of applying slings and ropes to hooks, barrels, etc., and a few other wrinkles useful to those engaged in workshops. Should a rope be too long for some temporary purpose, do not cut it, but arrange it as at (*a*); if several bights are laid up to shorten the rope to the required length, pass the standing part through and over the ends of all, and pull tight. At (*c*) is shown how a sling or strap should be applied to a hook when the rope spreads away to its load; this hitch prevents the sling from slipping in the hook in case the load comes in contact with some obstruction while being hoisted. At (*b*) and (*d*) is shown how a smaller rope should be secured to one of greater diameter. The Blackwall hitch is illustrated at (*e*); except for very light loads, this should be made with the end *twice* around the hook (called a *double* hitch), as in the figure; experience has proved that this is the safest way, since with only one turn, the end is liable to "creep" when subjected to a heavy pull, especially in damp weather, when the moisture absorbed by the rope serves as a lubricant. When a rope is too long to conveniently secure its end to a tackle, a bight of it twisted as at (*f*) is very handy and useful; to make this hitch, commonly called a *cat's paw*, take hold of the rope with both hands at places about two feet apart and twist it two or three times either way; then apply the ends of the loops thus made to the hook; the twisting prevents the rope from becoming jammed, and the hitch is very easily undone. At (*g*) is shown a *timber* hitch, so simple that explanations are unnecessary. At (*h*) is shown how to apply a rope to a barrel or similar vessel when, for some reason or other, it is desired to hoist it in a vertical position. At (*k*) is shown what is known as a *parbuckle;* this hitch is used for raising a heavy cask or similar load with a single length of rope. The illustrations that are here given explain the last two hitches much better than can be done in words.

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MACHINE DESIGNING AS A PROFESSION—TWO WAYS OF DESIGNING—DESIGNER AND DRAFTSMAN. SHOP AND DRAFTING ROOM—THE PRACTICAL EXPERIENCE NECESSARY TO A DESIGNER.

PART I.

MACHINE designing is a profession, and as such involves certain attainments, mental and otherwise, distinctly its own. But it is not represented "officially," so to speak, in the long list of professions that have branched from the parent stem of engineering, neither do our colleges confer degrees on those who make machine designing their special study. True, the mechanical engineer—the M. E.—is supposed to know something in a general way about machinery, but he may or may not be a machine designer; his title, therefore, is not sufficiently distinctive to be applied to the machine designer, neither does it cover all the ground, because machine designing forms a part of every *other* branch of the engineering profession, and the mechanical engineer is little less dependent on the machine designer proper than is the civil or the mining engineer, the steam or the electrical engineer, the millman or the metallurgist, the chemist or the technologist. In view of these facts and the consequent steady demand for competent designers, it is more than surprising that machine designing is not recognized as a profession by itself, that it is looked on by many of the diplomaed members of the engineering profession—the M. E.'s, E. E.'s, C. E.'s, and so forth—as a sort of "handicraft" indispensable, may be, as an ally, yet by no means entitled to be placed on a par with their own scientific calling. Good machine designers can stand the slight; they experience no difficulty in holding their own. The most regrettable thing about it is that, on account of the meager appreciation from the other branches of the profession, the needs of the future machine designer are not fitly provided for at our colleges and technical schools, and that, in the large workshops and engineering establishments of our country, few facilities are offered for the development of competent designers. The road that the would-be designer has to travel in order to gain his end is therefore a hard and laborious one, and its difficulties have turned aside many a young man who, by his talent and scientific knowledge, was eminently fitted for the profession. Good machine designers are, therefore, comparatively rare, as any one who has ever had need of their services will admit. This may strike many as a rather bold statement, in face of the fact that American machinery is finding its way everywhere and that American designs are unsurpassed.

But there are two ways of designing machinery; one we will call the method of *evolution*, and the other the *synthetic* method (which means "a method of deducting consequences from general principles"). The first is the older and formerly the only possible method, but it is still pursued by the majority of machine builders; it is the cut-and-try method, by which an idea is evolved, first in a crude way, and brought to final perfection by slow degrees, step by step, through years of experimenting, by altering and adding and changing about. In this manner most of the wonderful labor-saving machinery has been evolved. That this is a slow and expensive process no one will deny. It will also be apparent that to a certain extent any new machine or device will have to go through an evolution of this sort. But, with the enormous amount of experience that has been had during the last fifty years, it should be possible, and *is* possible, to at once produce a machine that will do the work required of it to a reasonable degree of perfection, so long as the principles involved in its construction are not beyond what are well known. This is what constitutes the other method—the synthetic. That it is not followed to as great an extent as might be expected is evidenced by the fact, well known to the public in general, that, in the line of machinery, it is next to impossible to have anything new built without the expenditure of an enormously disproportionate amount of time and money. This expenditure has long been accepted as a necessary evil, and is naturally ascribed to greed, almost bordering on dishonesty, on the part of machine builders, which, however, is only partially true, it being a fact that in spite of the

enormous prices asked and paid for special work, machine builders actually do not as a rule find it profitable to execute it—to do a general machine business, as the saying goes —but prefer to manufacture some specialty. The seeming contradiction presented by these facts is explained by the method of design employed: When, in order to obtain one *perfect* machine, it is necessary to build six machines, each a little nearer perfection than its predecessor, it is not to be wondered at that the aggregate cost of the job, and therefore the price asked by the manufacturer, is about six times too great. But, if there is such a thing as machine designing, have not the public a right to expect that a problem shall be solved "first shot," the same as it is in bridge designing? What should we think of the civil engineer who had to span a river half a dozen times before getting the final and satisfactory bridge? No wonder our brethren of the other branches cry down our designing as empty guesswork. As a further proof of the above assertions, it will be shown later that not a few of our best and most admired machines bear still the distinct earmarks of the evolutionary process.

This state of affairs is due to the scarcity of competent designers. Some of the larger machine-building concerns realize this, and have among their highest-salaried employes a number of designers, quite distinct from the ordinary drafting force. Some call them their consulting engineers, some their inventors, following in this respect the example of Thos. A. Edison, who first, with more or less justification, called inventing a profession; they themselves would most likely prefer the name designer rather than consulting engineer, which means everything and nothing, and rather too than inventor, which, in spite of Edison and the dictionaries, carries with it a notion of the accidental, or of some sort of "mahatma" inspiration, which is contrary to what is acknowledged to be true, namely, that machine design is based on hard work, pure research, and long experience.

In the above paragraph we have spoken of designers "quite distinct from the ordinary drafting force." We have also stated that in our large shops few facilities are offered for the development of competent designers. These two things are closely connected. A greater distinction should be made between designers and draftsmen by all parties concerned, be it manager, engineer, or mechanic. On the part of the employer it is unreasonable to expect a man to whom he pays a draftsman's salary to be at once a designer; on the part of the mechanical engineer it is a case of "sour grapes" if he fails to make such distinction and to recognize the designer as his equal; on the part of the artisan and mechanic it is a case of a long-nourished grudge—only too well founded in many cases—against every one connected with the drafting room, which dims his sense of distinction, and prevents him from recognizing in the designer his best friend and ally.

We ask to be allowed to dwell on the subject of the grudge just mentioned, albeit an old story.

At the peril of engendering the wrath of the shop foreman or superintendent, let it be stated that the drafting room ought to be the fountain head of the machine shop; it should have more to say than it generally has, and its rulings should be final—always under the strict understanding, however, that it is competent to exert such authority. A gang of mere draftsmen alone will not do. We cannot blame the practical machinist—who knows his business, and from whose ranks have risen, by hard struggle, our most successful machine designers—when he most strenuously objects to the blunders of the young college-graduate M. E., especially if the latter, conscious of possessing sound and superior knowledge, shows a certain amount of, albeit pardonable, conceit; or to being advised so and so by the former office boy, who grew to be a member of the drafting force from numbering and filing drawings, and making blueprints; or even to abiding by the judgment of his former associate in the machine shop, who has in some way mastered the noble art of mechanical drawing and no more; not to speak of the many other types of so-called mechanical draftsmen, the "me-toos," who, after many shipwrecks in life, have taken to drafting—or, better, to tracing lines—as a congenial and easy way of making a scant living. Such men, the young graduate not excepted—though we are sorry to have placed him for the time being in company with those that in his judgment are doubtless inferior to himself—should not be allowed to assume authority over the man of the shop. It is a humiliation to the latter that he cannot be expected to bear. We will assume that, as in every high-class drafting room, the force is presided over by an able chief, assisted by one or two competent designers, and that as is usual the former transmits the orders from the drafting room to the shop. If the

chief is the right man in the right place, there will be no antagonism between the departments.

The above seeming deviation from our subject nevertheless brings us right back to it; for it is upon the character of the relation between drafting room and shop (people more fond of scientifically expressing themselves would say between *theory* and *practice*) that depend the facilities offered by a concern for the development of machine designers. Shutting off all communication between drafting room and shop, save the legitimate channel through the chief, must effectually deprive the draftsman of all means of development as a designer; on the other hand, too free a communication produces the grudge already referred to. A system that is successfully employed by a Brooklyn concern, and gives the draftsman opportunity to learn, is a great help to the draftsman, increases the efficiency of the department, and, last but not least, is not apt to disturb the peaceful relations between the drafting room and the shop, is as follows: An order having been passed in from the office, it is assigned by the chief to one of the designers, who selects one or two of the draftsmen. The plan to be followed having been outlined and determined by the designer, it is carried out in detail by the draftsman, under the supervision of the former. All drawings bear the signatures of the chief, the designer, and the draftsman, *as such*, before they are sent into the shop. The responsibility is thus clearly apportioned. The draftsman, being the lowest-salaried man in the combination identified with the job, is detailed to the shop, and charged with the following up of the work as it proceeds, reporting any trouble that may arise. To be sure, he is quickly made acquainted with whatever blunders he may himself have committed as draftsman; he also hears the mechanic's criticism on the design of his superior, and, reporting this, hears the latter's refutation or approval. He has helped to build the machine in theory, that is, on paper, and he sees it take actual form; he realizes the difficulties attending the making of the various parts, forms ideas as to time and expense—in short, learns a lesson of great value to himself as well as to his employer, and a few years of such practical instruction are apt to make him a pretty fair designer.

In thus recommending a plan to be followed by a machine-building concern that is willing to offer advantages to their draftsmen, it is intended to indicate the course to be pursued by the man who wishes to become a successful designer, rather than to give points to chiefs and managers, as in most cases the would-be machine designer will have to gain his end by his own individual efforts. The series of articles here begun is meant to aid him in these efforts.

In the above, speaking of drafting-room practice, we have tacitly assumed that the position from which a designer starts on his career is that of draftsman. This assumption is correct. Drawings are the language of the designer, and he must be a good mechanical draftsman first of all. Where and in what manner his proficiency in the art has been acquired is quite immaterial; the college graduate stands no better show than the machinist draftsman. Next, what has been said points decidedly to the advantage of gaining experience by shop practice. In this respect the machinist has somewhat the advantage over the college M. E. He has, no doubt, by long association with the methods of the shop, gained a valuable and *perfect understanding as to the best ways for the mechanical execution of work*, the capacities of the various machine tools, and so forth. The information of this nature that is imparted to the student of mechanical engineering in our technical colleges, equipped with more or less extensive workshops, can at best be but fragmentary, and must be regarded as a meager substitute for actual training in the commercial workshop. Not that we wish to run down this part of the college training; on the contrary, the maintenance and constant improvement of these college workshops deserve fervent approval, especially in view of the difficulty young men experience in gaining admission, as apprentices, to large establishments, and even if admitted, the difficulty of learning much within a reasonable length of time—there being no one to teach them. The student who is fortunate enough to secure the position of apprentice under a master who understands his object and is sufficiently liberal to help him gain it, should eagerly grasp and improve every opportunity to learn, as being of inestimable value to him in his future career as a designer.

We have emphasized by italics in the above paragraph the words "perfect understanding as to the best ways for the mechanical execution of work." We did so because in the main this is *all* (though forming a goodly portion of the total sum of attainment needful to make a designer) that an apprenticeship can give him, and is all that he need

strive for while serving it. The acquisition of superior dexterity in handicraft, forging, filing, turning, patternmaking, molding, etc. is *not* necessary. The designer's handicraft is drafting.

Again, long association with shop work alone does not, strange as this may at first seem, help to impart to the would-be designer those notions of combinations, shapes, and dimensions that constitute his needful experience. This being a matter of considerable importance, it is well to more fully explain: Suppose a machinist has worked for a considerable length of time in a shop where machines of a certain class are made; he will probably know all the parts of these machines, their shapes, their dimensions, their functions in the combination, and, as the machines work well, will consider them patterns after which pieces in similar combinations should be modeled. This is dangerous, so long as it is taken for granted that the pattern is right without a full understanding why. It leads to those thoughtless methods of designing machinery by empirical rules and formulas, by proportional scales, by units—methods almost universally practiced and taught in our colleges as "machine design" to such an extent as to make machine designing appear a mere matter of routine. The designer must look at every perfect piece of machinery as suitably shaped and proportioned in that one and particular case alone, and must determine by careful consideration and investigation whether it is admissible to just multiply the dimensions of any piece by a factor to make it fit another case, even though a similar one. We shall in due time revert to this matter, and indicate the limits within which the methods characterized above are useful and justifiable.

Existing designs cannot rightly serve except as examples or suggestions, but familiarity with them *as such* (and the more of them the better) constitutes the practical experience of the designer—part of his stock in trade, so to speak. It is evident that the machinist-draftsman has had more opportunities to gain such experience than the college graduate, but if he has grafted on his memory existing forms, dimensions and combinations, without regard to the prevailing circumstances and conditions, this experience will avail him little; he must be able to sift all this material, and to do this he must have theoretical knowledge of the underlying principles. The college graduate, with this requisite knowledge at his command, has thus a decided advantage; *his* difficulty will be to accumulate practical experience; he will have to concentrate his energies on observation and on the analyzing of existing designs, while the machinist-draftsman will first of all have to sit down and study. The road is as hard for the one as for the other.

(*To be Continued.*)

IN THE WORKSHOP.

(*Continued from the June, 1899, Number.*)

H. Rolfe.

FITTING IN TAPER PINS—OVERDRIVING THEM—JUDGMENT IN MAKING PRESS FITS—FORCING IN SIDE-ROD AND OTHER BUSHES—THE NERVOUS WORKMAN.

ONCE upon a time a gentleman named Robert Bruce had a little family quarrel, the other party to the dispute rejoicing in the name of the "Red Comyn." In those days, when men fought to kill time—and each other—quarrels were plentiful, there being nothing much else to do; and these little bickerings generally ended disastrously for all concerned. The quarrel in question came to a crisis in a church, of all places, Bruce exercising himself on his relative with a sword. On coming out of the edifice, he naturally looked a little perturbed (though it took a good deal of this sort of thing to upset a man's equanimity in those days), and a friend asking him what was amiss, he replied, "I doubt that I have slain the Red Comyn." "Well," replied his friend, "I'll mak sicker." And forthwith he rushed in and, with the aid of a businesslike dagger, put the matter beyond all doubt.

The writer read this story thirty years ago, but remembers it distinctly now, the pains that the third party took to *make sure*, being rather striking—literally so for the Red Comyn. Now, there is a lot of this "making sure" at the present day in the

iron trades, in both shop and office. We will take the latter first, choosing a detail, and a small one at that, to begin with, namely, the motion pins of a locomotive engine. In American practice the eccentric rods and rocker-pins are in reality bolts, with heads and nuts as ordinarily. In Europe it is customary to support the link by hangers on either side; not only so, but

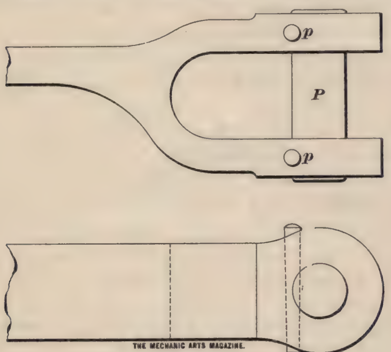


FIG. 1.

the valve-stem centers are brought pretty close together, so as to get larger cylinders in. Now, this necessitates a *set* in the valve-stem guide, and to keep down this set the eccentric rods are made practically flush with the eccentric-rod jaw, as shown in Fig. 1, the link-block pin being also flush with the jaw of the valve-spindle guide; thus the hangers can be set closer in and the links kept closer together. The pin P is "lapped" in, and the holes p drilled and reamed in place, the hole being halved between the pin and the eye. Now, if the pins p are fitted in properly, there need be no fear of their coming out; on the contrary, they are one of the most troublesome things to *get* out when stripping an engine. The very slight taper that they have has much to do with this, and also the fact that nervous engineers (who, not being mechanics, cannot be expected to know how tight to make such things) often knock these pins down with a coal pick, "to make sure." It would be fair retribution to make these men knock them out again. But we shall allude to this later.

Engine runners are not the only transgressors in the matter of overcaution. The designer, who, we will assume, has had no shop experience of any real value (as is the case with the majority), not knowing the holding power and reliability of a properly fitted taper pin, goes a step further and makes it a split one also. Now, taper split pins are all right for crank-pin washers, for we know that crank-pins undergo constant shocks, great and small, to say nothing of their swinging around in a 2-foot circle from five to six times a second. And here comes in another point, seemingly insignificant and often neglected; we allude to pressing the crank-pins in so that in revolving, the small end of the taper pin shall lead, arranging them as in Fig. 2, and not as in Fig. 3. In Fig. 2, centrifugal force is all the time tending to *tighten* the pin; in Fig. 3, it is tending to *loosen* it—to throw it out. Now, the effect may be slight, but we hold strongly to the following maxim: Where there are two courses open to the designer, the one a little more advantageous than the other, choose that one, no matter *how* small its advantage may be. In the present case, for instance, we have a certain amount of centrifugal force due to the weight and motion of the pin, and we can arrange things so that this force tends either to loosen the pin or to tighten it; we ought to immediately choose the latter, even though the advantage be but microscopic, and note the drawing to that effect. We contend that this seizing and making use of small advantages that already exist and are not of our own making, should be encouraged, and by no means classed with those efforts "to make sure," which are the offspring of nervousness and ignorance. In the majority of cases, the taper pin is set at right angles

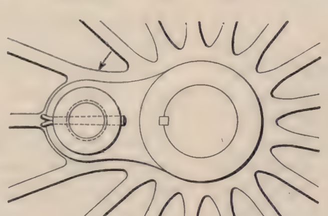


FIG. 2.

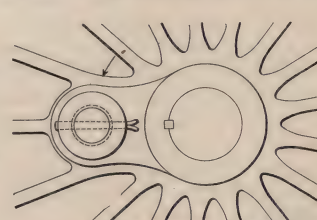


FIG. 3.

to the crank; we will not now discuss this point, merely remarking that we prefer the arrangement shown in Fig. 2.

As an illustration of overdoing a thing, we quote a case where the designer was evidently impressed with the value of "draft" in keying up; he, forsooth, went to work and put draft on a taper pin. He knew it was

necessary to keep the pin fast in the jaw, so he made his drawing as in Fig. 4. As to how the draft would be put in, in the shop, he neither knew nor cared—perhaps thought they would *file* it. We don't know how they *did* it (extremely probable they *forgot* to do it), but should think the only way would be to fit the pin in the usual manner and afterwards use a safe-back reamer of section shown at *R*, and thus

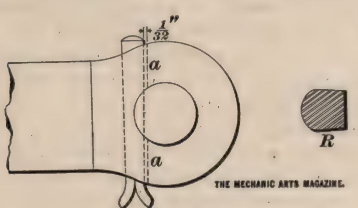


FIG. 4.

work out the metal as called for. This design struck the writer as being a very amusing refinement. The designer evidently had in mind that if the pin got loose, this draft would enable the engineer to tighten it up again, but he defeated his own ends to a great extent, for removing the metal at *a* and *a* relieves the pressure on opposite parts of the pin, and thus less holding power is obtained than if the pin were "solid" throughout its depth.

It has been said above that engine runners sometimes drive these pins in too tight; that is one of the things that shopmen have to put up with. When stripping an engine, the writer has often found it impossible to get these taper pins out, especially when split—in which case there is nothing solid to hit at; and when they are solid, the more you hammer them the more you upset the end, which makes matters worse. Often, after ruining every punch we could beg, borrow, or steal, we have at last had to get a flogging hammer and drive the motion pin itself out bodily through the jaw, shearing off both taper pins. We can see the look of horror on some of our readers' faces at the mention of such sacrilege; but if they had been in a rushing shop, where one fitter had not only to get an engine ready for lifting, but strip her entirely, and no excuse taken for being long about it, they would have done as we did; if anything got sprung or bent—well, that was left to the bench fitters, whose duty it was to send things back ready to go up.

Speaking of driving in the pins too tight brings us to that part of the fitter's professional equipment which may be called *sense of touch;* this comes to one in time. A taper pin, properly fitted, needs but little driving home. There is no need to swing your hammer over your shoulder until it reaches the small of your back; a 4-inch lift will do. It is hard to tell in words just how to drive these pins, and it may seem a small matter at most, but erecting-shop and round-house men will appreciate the spirit in which these remarks are made—*they* have to get the pins out again.

The sense of *feeling*—the ability to judge how tight to make a certain detail—is constantly being called into requisition, in keying up crossheads, for instance. Who has not seen the green hand banging away at a cotter for all he was worth long after the thing had been drawn up solid? He is putting a new end on a piston rod, and is keying it up on the bench; the rod is designed to bottom in the crosshead, as it *ought* to. Now, a man who is not altogether without the making of a machinist can discriminate at once between the resistance due to the conical fit and that offered when the rod is "home." There is a solid feel about it in the latter case that there should be no mistaking—unless the man has mistaken his vocation. The writer once derived not a little amusement from watching a brawny apprentice (in his last year, too) using his lead maul with more strength than discretion. After about a dozen "try-ons" the rod at last bottomed, but he knew it not, and when he knocked his cotter out it was somewhat as in Fig. 5; the joke of it was he could not make out the cause. It is easy to get a cotter $\frac{1}{8}$ inch hollow this way.

There are many other cases where accurate sense of touch is required—in knocking down axle brasses, for instance. The old style of octagonal brasses, in which both brass and box were fitted up out of the black, is out of date; instead, the box is bored out and the brass turned up and pressed in sideways, by air or hydraulic pressure. As regards saving of time and expense, and getting a better job, this is, in our opinion, one of the greatest improvements ever made in locomotive construction, provided the lower edges of the brass are cut at an angle to keep it from closing in under wear and pressure. Sometimes the brass is cast solid in the box, or rather, to be exact, the box is cast around the brass; it then has flanges, and when the brass is worn out the box is broken up and melted. The writer at one time worked in a shop where this style of box was used, and

FIG. 5.

remembers being puzzled for a minute as to how the thing was got in—somewhat as King George III was over the apple in the dumpling.

A misplaced and thoughtless exertion of brute force is often seen, too, in putting in side-rod bushes. It is astonishing how some men, good workmen, too, seem to lack judgment in this matter. Simply another instance of following up an idea too far—of overdoing it, in fact. They think that because a bush requires to be tight, the tighter it is the better. Now, a bush *can* but be tight; after that is reached you are merely going to close the bush in or else spring the eye. Anyway, we opine that many a rod has failed in the eye, owing to the bush being put in too tight. The only thing to do is to put them in in a press, and if they show signs of acquiring much more than the legitimate pressure (10 tons is ample) take them out again. We have seen bushes put in, under the screw press, dangerously tight; the workman gets the bush in about three-fourths of the way and then rather than take it out again "makes her go"—putting quite a strain on the rod end (an especially undesirable thing if the latter has been case-hardened) and closing his bush in so that he has less play in the pin than he allowed for. Sometimes these rod ends wear a little large one way, especially where there has been a loose bush. Then, instead of boring it out, or lapping it, if hardened, or filing up the brass, he simply puts the latter in as turned, and relies on an extra-tight fit to make the bush fill the hole.

In regard to fitting operations, putting brasses in axle boxes, fitting in piston-rod ends, main- and side-rod brasses, etc., it is interesting to note how the temperaments of different men assert themselves. Take two men, B and C, for instance: B makes all his gauges "full," for the planer or shaper; he hasn't enough confidence in himself, can't trust his calipers—likes to "make sure" that he will have enough stuff to work on, so he leaves his gauge full; if he is doing his own machine work, as is sometimes the case in small shops, he is equally cautious. The result is, he has a terrible lot of filing to do. C, on the other hand, works pretty close to size, especially if he knows his man. If he is doing his own machining, he works equally close, the result being that he can take his big-end brass, say, out of the machine and shove it half way down the strap first time. B has to do a lot of filing on the flanges and two faces before the thing will enter at all. Or, again, suppose the piston rod has been reended and is being turned up ready for fitting in the crosshead. B will leave his too big, and it won't go home at the first driving within $\frac{3}{8}$ inch. C will get his taper carefully, noting whether his crosshead fit is at all hollow, and then go ahead, and when done will drive the crosshead within $\frac{1}{8}$ inch of home the first time. We do not recommend having much less than $\frac{1}{8}$ inch at the first driving; we should leave this much for getting a good bearing and for pulling up with the cotter. (We are not dealing with "ground fits" just now.)

Even if you start the two men on equal terms, C will "try on" only about half as often as B, with the result that his axle brass (if that is the job) will be a tighter fit when finished, for most of the trying on is done when the brass is nearly home, and every time the brass is knocked in and out the slacker it gets on the gripping faces, and by the time B has got his brass bedded down, the holding power is nearly gone—perhaps entirely—in which case he puts packing between the collar and the brass and lets it go; he knows it will hold while being bored out, and for the rest he doesn't care so long as the erector passes it; but all the same, that brass will be knocking in the box before a couple of weeks have passed. B, again, if fitting in a new reversing-piston bush in a Westinghouse air pump (repair work) will knock it in many more times than C would, who in this, as with other details, sees at an early stage just how he stands, and goes ahead accordingly. If, in addition, B has no sense of touch, he will drive away too hard and end by jarring the bottom of the bush off, or, like as not, will leave the bush so tight that it closes in at the top, where the taper fit is, and thus makes the pump slow to get away from the bottom of the stroke. Or, if pressing in a new reversing-valve bush, he will be afraid to work to his calipers, and so "to make sure" of its not being slack, will leave it too big and perhaps end by cracking his cover, if not warned in time, which he won't be, as we are assuming him to be devoid of that sixth sense that tells you how much work you can put on to an object of given form and material. Or, his lack of confidence may assert itself differently, and being afraid to put the bush in tight enough (to insure the proper steam fit) will get it too slack, and so when it is put on the test rack he will find that he has to knock it out again and put in another.

This matter of courage in the shop is an

interesting point. It is altogether different from moral or physical courage, as understood in every-day life. Sometimes a little atom of a man, who is frightened at his own shadow, outside on the street, corresponds to our imaginary friend C, while, on the other hand, the terror of the neighborhood may be our friend B—a man who will shake in his shoes if put on a strange machine, or a new job, or set to strip and lift an engine by himself. Such men can work all right under another man's direction; they are generally good workmen, so far as mere manipulation of tools goes, but if they are put on a fresh job, only slightly different from what they have been used to, they get rattled. The other class, however, are often indifferent vise hands, but no job comes amiss to them—laying out, templet making, machine and engine breakdowns and repairs of all kinds, millwrighting, etc. In short, they don't *like* to stick on the same job year after year; they prefer variety, something strange and new every time. These men are exactly the ones to make foremen of; the man who is merely a good bench hand is no good for foreman. Get him used to a job and then keep him there for the rest of his life. He will give good satisfaction—ten times as much as the other man would—and you will get both speed and quality out of him. In fact, it would be rather a pity to waste a good workman like that by making a foreman of him; he would not be so happy, either.

(*To be Continued.*)

HOW SHOULD KEYS BE FITTED?

Carl G. Barth.

Should a Key be Fitted Top and Bottom, on the Sides Only, or All Around?—The Best Shape for a Key.

WHAT a simple, every-day job it seems to the machinist, who has been brought up a certain way in a certain shop, to fit and drive a key properly. Of course the machinist knows all about it; and he is not likely to take kindly to anybody who may happen to suggest that there is another way of doing it besides his, particularly if that new *busybody* should venture to claim any advantage for that other way. If, however, our friend gets around a bit among other shops, he finds that there is not only *one* way, but a *number* of ways, besides his, or rather, besides that of the shop in which he served his time. He will also discover, probably to his surprise, that there are few subjects in mechanics in regard to which opinions differ so much and so widely. And, further, these differences of opinion exist not only among machinists, but to a still greater extent among machine designers and engineers, who frequently get into heated arguments about the matter.

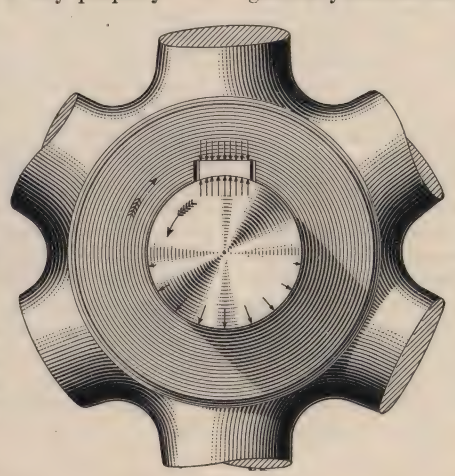


Fig. 1.

The questions about which the discussions generally arise are as follows: (1) Is a *square* key better than a *shallow* key? (2) Should a key be fitted top and bottom only, or on the sides only, or top and bottom as well as on the sides?

Let us see whether, by a careful and unbiased consideration of the most common forms of keys and the various ways of fitting them, we can gain some insight into the manner in which a key performs its function as a driving link between the shaft and the hub that it drives, or by which it is driven. A little thought will then enable us to defend our present practice, if it is good, and we shall feel no hesitation in giving up our old ideas on the subject when they are shown to be wrong.

In connection with all the accompanying illustrations, we will suppose the shaft to

drive the hub in the direction indicated by the inside arrow, or the hub to drive the shaft in the direction of the outside arrow, these two different suppositions being in every case identical as regards the action on the key.

In Fig. 1 is shown the *saddle*, or *concave*, key. This appears to be the only form about which opinions do not differ, as it evidently drives merely by the friction that it gives rise to between the surfaces of the shaft and the hub. For this reason its driving power is very limited, and it is accordingly made use of only in cases where adjustments between the hub and the shaft have to be made after the erection of the machine, and when, at the same time, the slipping tendency is but a small fraction of the twisting strength of the shaft. There would evidently be no advantage in having this key fit tightly on the sides, so far as driving power is concerned; for, if the friction between it and the shaft is sufficient to prevent slipping on the curved surface, the friction would also be sufficient to prevent slipping at the top surface of the key on its seat in the hub. The thickness of this form of key is evidently of no consequence, and therefore it is a matter of taste and convenience only.

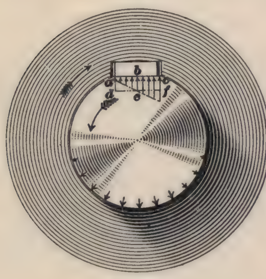


FIG. 2.

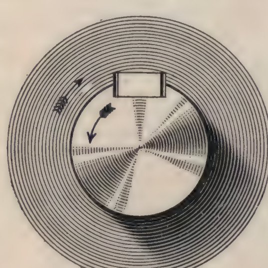


FIG. 3.

Fig. 2 shows the *flat* key. Though the driving power of this form of key is greatly increased by the friction due to the pressure between the surfaces of the shaft and the hub, we will, for the sake of argument, neglect this and consider only its *direct* driving power.

Suppose, then, that the shaft drives the hub in the direction indicated. It will be seen that points on the flat $a\,b\,c$ of the shaft, to the right of the center b, will be thrust hard against the key; whereas, points to the left will tend to move away from the same, the result being a redistribution of the pressure between the shaft and the key, and consequently, also, between the key and the hub. Its intensity will be lowered to a minimum at the extreme left-hand corner a, and raised to a maximum at the extreme right-hand corner c, the original intensity of pressure being retained at the center point b only. This has been indicated in the figure by the vertical arrows, whose lengths are intended to represent the intensity of the pressure at the different points; the straight line $d\,e\,f$ similarly represents the original, uniform intensity of the pressure that is due to the tight driving in of the key.

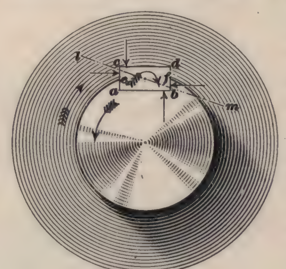


FIG. 4.

It is evident that the effectiveness of this form of key will increase rapidly with its width, and that it is independent of the thickness of the key. Very little thought will also convince one that nothing is gained by making it a tight fit sidewise in the hub.

Referring now to Fig. 3, we recognize at once that a *sunk* key which does not fit on the sides, but is a driving fit between the top and bottom only, must, in every way, act as the flat key just considered.

If, however, the sunk key also fits tightly on the sides, as illustrated in Fig. 4, the conditions become entirely different, and, as a consequence, the driving power of the key is enormously increased. In this case, the key will, in the first place, receive the greatest pressure from the shaft along the shallow surface $b\,f$, and from the hub along the shallow surface $c\,e$. But these surfaces and pressures, not being directly opposite to each other, the latter will tend to turn the key around in its seat in the direction indicated by the arrow. This tendency thus thrusts the corner b harder down against the shaft, and the

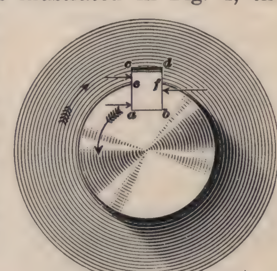


FIG. 5.

corner c harder up against the hub, until the combined effect of the pressures on both sides of the corner b will be directly opposed to the combined effect of the pressures on both sides of the corner c, along some line $l\,m$ through the center of the key.

The action is such that it makes little difference whether the key is, in the first place, driven in very tight or not, so long as it is perfectly home against all the faces surrounding it; but it is of advantage to make the width of the key greater than its depth, in order that it may not have to turn around too much to bring its corners b and c to bear sufficiently hard against its bottom and top seats, respectively. If it is made narrow, the consequence of this turning action will be too much concentration of the pressure towards the corners b and c of the key, and towards the corners e of the hub and f of the shaft.

In order to better understand the action of a key sunk half into the shaft and half into the hub, but fitted sidewise only, we will first consider the feather key, Fig. 5. It is supposed to be tight in the shaft only, and to be quite free, even sidewise, in the hub. Driving as indicated, it receives the pressure of the hub along the face $c\,e$. This pressure will then act upon the key as a prying lever, thrusting it hard against the side $b\,f$, in the neighborhood of f, and hard against the side $a\,e$, in the neighborhood of a; and it is obvious that the intensity of the pressures produced at the points f and a will be less the deeper the key is sunk into the shaft, and the less it extends into the hub.

Turning now to Fig. 6, which represents the square key not fitted tightly top and bottom, but sidewise only, we recognize a similarity between the action of the *shearing stress* through the middle section $e\,f$ of this key upon each embedded half, and the action of the pressure of the hub on the key shown in Fig. 5.

Considering first the upper half, we see that this shearing stress, extending, as it does, in the direction f to e, will thrust the key hard against the side $c\,e$ of the hub, in the neighborhood of e, and against the side $d\,f$, in the neighborhood of d. It thus exerts, on account of the short depth of the key, an intense prying action in the hub. In precisely the same manner, the shearing stress, which extends in the direction from e to f, will thrust the key hard against the side $b\,f$ of the shaft, in the neighborhood of f, and against the side $a\,e$, in the neighborhood of a, and will thus exert a corresponding and equal prying action in the shaft.

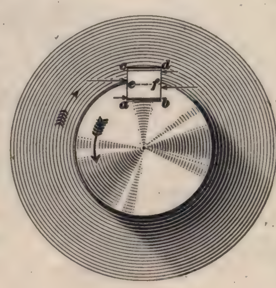


Fig. 6.

Evidently, then, this is not the way to fit a key, and we are forced to conclude that the ordinary sunk key must be fitted tight all around, as in Fig. 4, in order to serve its purpose in the most efficient manner; and also, that its width ought somewhat to exceed its depth.

I WONDER.

THE story is told that as a prominent politician walked along the street one day, in the company of a friend, he noticed a member of the opposition passing along the other side, with measured tread and head bent down, to all appearances wrapt in the deepest meditation. "Ah!" said he, "White looks as though he were thinking, doesn't he? But he isn't; he's only wondering."

This was no doubt intended as sarcasm, though it is possible it was also true, for this wondering instead of thinking is a very common habit, and a very bad habit too. How often we hear people say, "I wonder;" "I wonder so and so;" "I wonder how such and such a thing is made or done;" "I wonder why such a thing is so." The very word *wonderful* is evidence of our prevailing weakness. A thing is wonderful, because it fills us with wonder. Wondering is all very well in its way, but it should lead to *finding out*, otherwise it is a waste of time. It would be a good thing for all of us if every time we said "I wonder," we were to add "and I will try to find out."

TAKING PORTRAITS INDOORS.

Louis Allen Osborne.

Study of the Subject—Arrangement of Light—How to Fit Up a Home Gallery. Exposure and Development.

IN PHOTOGRAPHY, one of the most difficult problems that confronts both the amateur and the professional is portraiture. Few possessors of a camera realize this fact sufficiently to take the trouble to study the subject scientifically, yet few of them leave it entirely alone. The old idea that a photograph cannot lie is a false one, as any portrait taken under improper lighting facilities will prove.

Now, if we are to make photographic portraits, we must consider a few facts outside of photographic chemistry. If the portrait is intended to be a good likeness in the opinion of the model, then we must bear in mind that the only way that a man gets any personal idea of his own appearance is by looking into a mirror, and that therefore he usually sees himself either full-face or three-quarter full-face. If a person has a fine profile, it is sometimes advisable to make a profile portrait, because the possessor of a striking profile soon learns the fact and will in some way contrive, by a combination of mirrors, to get a side view of himself. On the other hand, we must endeavor to as far as possible hide the natural defects of feature that our subject may possess, because, through custom and association, these defects seldom appear as bad to their possessor or his family as to the comparative stranger or outsider. For instance, a person with a snub nose never realizes its enormity until by accident or design he gets a view of his profile. We must be careful, therefore, when making a portrait, that we do not render these defects too apparent; it is not only necessary to avoid making them worse than they really are, but we must endeavor to avoid making them any worse than our subject *thinks* they are.

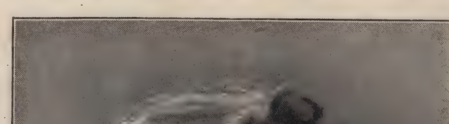


Fig. 1.

Some phases of human nature may be studied to more advantage in portrait photography than in any other profession, and the more observant the operator is of details of character and disposition, the more successful he will be in taking portraits. The details are matters of first importance, and unless due attention is paid to them, other considerations will be of little value.

It is by properly "lighting" the subject that strongly marked characteristics are emphasized and defects of feature subdued. Upon the strength, depth, and direction of the light depend nearly all the characteristics of the finished picture.

It certainly should not be necessary to tell the reader that a portrait should never be taken in full sunshine, yet there are many misguided amateurs who endeavor to accomplish this very thing. When taking a portrait, lots of light is required, and strong light; but *never* full sunshine on the subject.

Indoor portraiture, which is all we will discuss at present, requires a much longer exposure than open-air portraiture, the intensity of the light being much less; but with the arrangement of screens and reflectors herein described, a well-lighted indoor portrait may be made with an exposure of

four seconds, that would require four times as long without reflectors, and would even then be poorly lighted.

In all professional photograph galleries we find the sitter illuminated from a skylight. It is therefore reasonable to assume that the best results are obtained when the light comes from above the subject. In the gallery we also find several white or gray screens that the operator moves about into various positions, to reflect the light on the side of the subject so as to get just the character of illumination he desires.

In our arrangements to make portraits at home, then, it will be best to follow as far as possible the methods used in the regularly equipped galleries. Skylight we do not possess, but we can soon, and with very little trouble, provide a substitute that is very

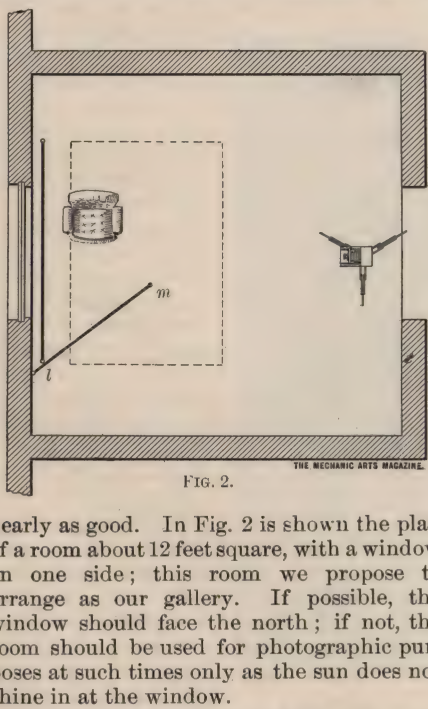


FIG. 2.

nearly as good. In Fig. 2 is shown the plan of a room about 12 feet square, with a window on one side; this room we propose to arrange as our gallery. If possible, the window should face the north; if not, the room should be used for photographic purposes at such times only as the sun does not shine in at the window.

The window should be covered with some opaque material to a height of about 5 feet from the floor, or to the meeting rails of the sash. Heavy, rough, bookbinders' board is excellent for the purpose, as it can readily be cut to exactly fit the space. Over the lower part of this window, and against this opaque covering, should be hung some fabric to form the background; its color should be varied according to the character of the subject to be photographed. Dark subjects call for a light background, and vice versa, though an absolutely black or white background is seldom used.

A most excellent material for a background is ordinary cambric or silesia, of a drab color. This should be moistened by sprinkling, and then stretched on a frame about 5 or 6 feet square. If it is necessary to sew together two or more strips in order to get the required size, this will make no difference, as the seams will not show in the picture unless the background is brought into focus, and this it should not be, unless a regular professional background is used.

Across the ceiling, about 18 inches in front of the window, an ordinary linen sheet or other white fabric should be hung, and after its top edge has been secured to the ceiling, its lower edge should be stiffened by means of a strip of wood, and the whole maintained at an angle of about 45° with the light entering the window. Under this white reflector, and in front of the background, the sitter is to be posed, as shown in Fig. 3, where *a b* is a section through the wall of the building, showing the window at *c d*. At *e f* is the background, about 6 feet high; *g h* is the reflecting screen, at an angle of 45° with *a b*. The bottom edge of screen *g h* should be low enough to hide the top of the background when observed in the camera *k*. A plan view of this arrangement is shown in Fig. 2; in this, *l m* is another reflector of white cloth or paper, so hung as to illuminate the face of the sitter and cut down the contrasts on the lower portions of the head and shoulders.

Now let us for a moment consider the effect of all this. The light enters through the upper half of the window, between *c* and *e*, strikes the screen *g h*, and is then reflected down on top of the sitter, *precisely as though it came through a skylight.* The bottom edge of the screen can, if desired, be lowered slightly, so as to throw the light more against the side of the sitter; or it may be raised, so as to deepen the shadows on the side nearest the camera. The screen *l m*, Figs. 2 and 4, can also be adjusted to get any desired lighting effect, and thus the amateur has the means of producing some of the most artistic effects obtainable with a camera.

To make a full-face portrait, the sitter should be posed about 2 feet in front of the background, and the reflector *g h* set so that the shadow of the nose falls on the upper lip; then the side screen should be set so that one side of the face is illuminated a trifle more than the other. It is seldom desirable that an absolutely full-face picture be taken;

therefore, after these arrangements have been completed, it is well to have the sitter turn the head slightly, so as to show a little more of the lighted side. This will produce a picture lighted as shown in Fig. 5, while the turning of the head *towards* the light will show more of the dark side of the face, and the result will be a picture lighted as in Fig. 1. To produce the condition of lighting shown in Fig. 1, the screen gh is so adjusted as to throw the light nearly perpendicularly upon the figure, and the side screen is so placed as to strongly light the face on the side away from the camera. This gives a sharp, clear outline to the profile, while the rest of the face remains in comparative shadow.

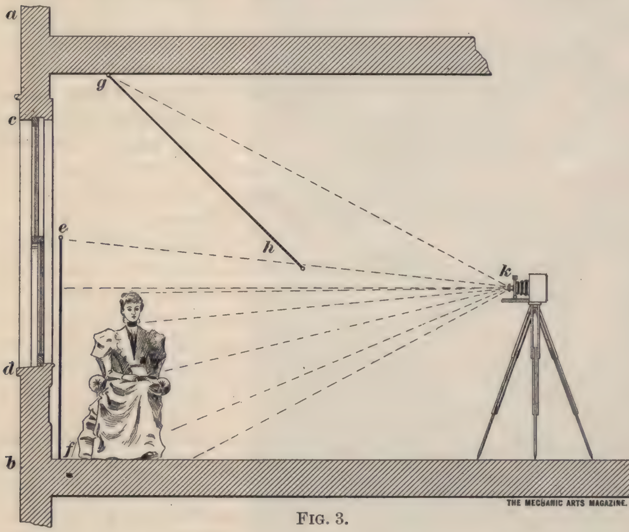


FIG. 3.

Where the photograph is to be a full-length figure or a three-quarters full length, care must be exercised that the upper part of the subject is not more strongly lighted than the draperies nearer the floor. It is well, on this account, to spread on the floor a white sheet or a number of newspapers, so that the light may be reflected upward against the lower part of the figure. Fig. 6 shows a subject posed to light the face as described for Fig. 5, while the lower part of the dress was at the same time strongly illuminated by reflected light from a sheet spread in front of the camera about 20 inches from the feet of the subject.

Where a person has light curly or fluffy hair, it is best to illuminate the hair brilliantly by setting the top screen about as shown in Fig. 3, and then arranging the side screen to reflect light on the face in an *upward* direction, so that as far as possible its stronger shadows may be softened and too much contrast prevented.

A little practice will enable the amateur to produce any kind of lighting desirable, to suit any particular style and character of subject to be reproduced.

Now let us consider the exposure of the plate, and the development of the negative. In the first place, only the fastest of plates should be used for indoor portrait work. Among the most common brands are the Cramer Crown, Eastman Red Label and Film, Seed 27, and Stanley 50. The Hammer Extra Fast is also a good plate, but it is not quite as rapid as the others named.

The camera should be near enough to the sitter to have a good-sized picture on the ground glass, but not so near as to produce a distorted picture. On a $4'' \times 5''$ plate the person's head should never be taken larger than one-sixth life size; nor should the camera be set nearer than 8 feet from the subject. The lens should always be worked at full opening, even though in consequence some details do not focus clearly. The camera should be placed in front of the background, as explained, and then focused upon the eyes of the subject. If the mouth and chin do not come out clearly, the swingback of the camera may be tilted slightly, so as to bring these details into focus. If the camera has no swingback, it is advisable to move it farther away from the sitter, and focus the image smaller. The back part of the head and the ear—if the latter shows—may also be out of focus, but this will do no harm so long as the ear does not thereby appear unnaturally large. Should the latter

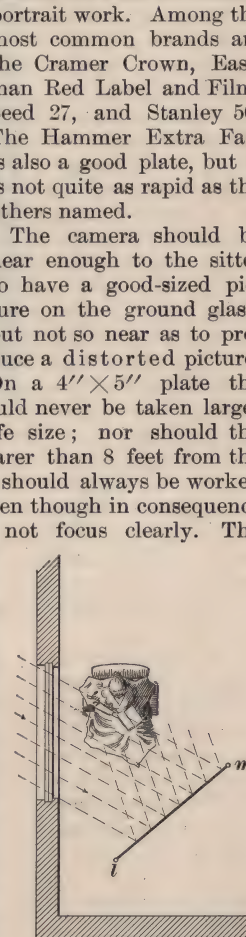


FIG. 4.

be the case, it will be wise to arrange the hair to cover the ear (as was done in Fig. 5) or to change the position of the head slightly, so as to render the ear less prominent.

The question of exposure is a difficult one to deal with. So many conditions of light, background, etc. enter into the determination, that no positive rules can be laid down; but in all cases of portraiture, the operator should be sure to give exposure *enough*. A very little practice will go a long way towards perfecting the judgment, and the operator cannot go far wrong if he goes by the following rules: If the window from which the light is taken faces north, give an exposure on a clear day, between 10 A. M. and 3 P. M., of 4 seconds; this is for the summer time, and where the room is in the second story, or, if on the ground floor, where there are no trees or houses nearby to obstruct the clear light from the sky.

In winter, under the same conditions, give 6 seconds.

If the window faces east or west, and the sun is shining on that side of the house, but not in at the window, give 3 seconds in summer and 5 in winter.

If the window faces east or west, and the sun is on the side of the house *away* from the window, give 8 seconds in summer and 10 in winter.

These exposures are based on the conditions of background, and color of materials heretofore described; if the sitter is wearing a white or a pale-blue dress, the exposure should be reduced about one-sixth or one-quarter; if the dress is black or red, the exposure should be correspondingly increased.

FIG. 5.

FIG. 6.

If the background is black, and a clear, well-defined outline is desired against it, the exposure may be shortened a trifle, say one-sixth; and if the background is dead white, the exposure should be correspondingly lengthened. This decrease for a dark background and increase for a light one may at first appear somewhat unusual, but when it is desired to get strong contrasts, the exposure must be short; long exposures tend to decrease the high lights and to render white surfaces less glaring.

With indoor work of the kind we are discussing, exposure is not a matter of as much difficulty as it is with outdoor photography, for the reason that the amateur, making portraits by the same window and under the same lighting conditions day after day, soon becomes as accustomed to the "timing of conditions" as does the professional photographer in his gallery. A few trials will determine the proper exposure, and after that serious errors should be of rare occurrence.

The next consideration is that of development; though many are of the impression

that so long as the exposure has been correct, development is *easy*, such is far from being the case in portrait work. Overdevelopment of a correctly-timed negative will destroy the lighting effects, and underdevelopment will give flatness and lack of detail.

The developer should be stronger than for ordinary landscape work, but not so strong as for snapshots, and should contain just sufficient bromide of potassium to make it work clear. Pyrogallic acid makes not only the best developer for portrait work, but is also the easiest to prepare. The following simple formula is recommended, as it gives excellent results and, being in two solutions, can be varied slightly, to suit different conditions. The proper working strength, however, is the one given, and variations should be made only to suit certain special conditions, as explained below.

A	Pyrogallic acid	1 oz.
	Sulphite soda (crystals)	4 oz.
	Water (pure)	16 oz.
B	Sal soda	4 oz.
	Water	16 oz.

To develop, take 1 ounce of *A*, 1 ounce of *B*, and 8 ounces of water, to which may be added 6 drops of a 10-per-cent. solution of potassium bromide. If granulated sulphite of soda is used, only half the above quantity of this chemical will be needed.

Place the exposed plate in a suitable tray, pour sufficient developer over it to cover its surface, and rock the tray slowly until the development is complete. The image should appear slowly, and gather density gradually; the development should be continued until the high lights are fairly dense, not so dense, however, but that the detail is still observable. When fully developed, pour off the developer, rinse the plate, and fix it in hypo as usual. Throw away the developer after once using it, as good results cannot be obtained from old solution, and the stock is too cheap to try to economize by using it twice. The above quantity of stock-solution developer should cost but 22 cents, and is sufficient to develop 44 plates of the smaller sizes, at a cost of ½ cent each.

Some kinds of printing papers require negatives of strong contrast, while others give better results with a weak negative. To produce the former characteristic, it is simply necessary to increase the proportion of solution *A* to 1½ ounces, and to add more bromide; softness and detail may be gained by increasing the proportion of solution *B* to 1½ ounces, and making the developer up with 10 ounces of water instead of 8. It is an excellent plan to make three exposures of the same subject on three different plates, and develop them with the three forms of developing solution above mentioned. The inexperienced amateur can then get a very fair idea of which is best suited to the conditions he seeks in his own case, and can govern himself accordingly in future operations.

Very satisfactory results are obtained with any of the gas-light printing papers, when a moderately thin negative is used, but for printing in platinum and carbon a little more contrast is desirable.

Glossy paper will require deeper printing than mat surface, as the latter appears darker when dry than when in the baths. It is always well to bear this fact in mind, especially in portrait work, as the depth to which a picture is printed materially affects the character of the finish. Only in the rarest cases is absolute black and white desirable in a portrait. Even where the draperies are in reality pure white, it is generally desirable to print the white parts of the picture deep enough to cause them to assume one tint darker than a pure white.

Bromide of potassium added to the developer of gas-light papers will tend to increase the contrasts, but in making prints by daylight these effects are obtainable to the best advantage by the proper treatment of the negative in development.

Never make blueprints of portraits. The color is not only most unsatisfactory for such a purpose, but the peculiarity of the paper renders it almost impossible to secure satisfactory detail.

A portrait must be a good likeness and a technically perfect photograph or it is useless, its defects always standing out more prominently than in any other class of picture. Therefore, do not try to get perfect results with improper papers or accessories.

After the negative is fixed, washed, and dried, a proof should be taken to determine how much, if any, retouching is required. Nearly all portraits require some retouching, the details of each feature being not always perfectly satisfactory as they are first impressed on the plate. Retouching is an art in itself, and should be done by a professional retoucher, until the amateur has progressed sufficiently in his lighting, exposing, and development of portrait subjects to be able to devote nearly all of his time and patience to the study of retouching. Learn to make perfect negatives first.

THE LEGISLATOR OF THE STARS.

George McC. Robson, M. A.

Fruitful Fancies—Astrology and Sorcery—The Laws of the Solar System—Kepler's Speculations on Gravity.

"Do not the hist'ries of all ages
Relate miraculous pressages
Of strange turns in the world's affairs
Foreseen by astrologers, soothsayers,
Chaldeans, learned Genethliacs
And some that have writ Almanacs."
—*Hudibras.*

England produces neither gold nor precious stones, yet her treasure houses are overflowing with wealth ; her damp flat fields and dull skies afford little inspiration for poetic or artistic fancy, yet her galleries are crowded with the noblest creations of art and her youth are nurtured on the poetry of Homer and of Dante. As England has gathered her material and artistic treasures from the east and from the west, so also has she enriched her language with the choicest words of all languages. In her vocabulary we find, side by side, the words that served the subtle Greeks in their deepest philosophy and the words in which the Romans proclaimed the laws that governed the world. In such a language it is both interesting and instructive to trace the pedigree and descent of words, and to note their relationships and intermarriages ; in this way alone can a clear conception of their finer shades of meaning be gained.

By studying the derivation and history of the word *astronomer* one gains a broader conception of the science of astronomy, and encounters some very surprising relationships. The word *astronomy* is derived from the Greek words *astron*, "star," and *nomos*, "law," and therefore astronomy is the science of the laws that govern the stars. But if we follow the pedigree one step further, we find that the Greek word *nomos* is derived from the Greek verb *nemein*, which means "to tend as a shepherd tends his flock"; in the light of this derivation, an *astronomer* is a "shepherd of the stars." It is interesting to compare the derivation of *astronomy* with that of the closely related word economy. The word *economy* is from the Greek words *oikos*, "house," and *nemein*, and therefore an economist is "the shepherd of a household."

The derivation of the word astronomer, as we have traced it, suggests that there are two distinct types of astronomers, whose functions are entirely different but which are both necessary to the progress of the science. There must be astronomers that are careful and accurate observers of celestial phenomena—men of clear eye and skilful hand—who do their patient and laborious work under the cold clear midnight skies of winter, and who fit out costly expeditions to distant lands to observe phenomena that are not visible from their fixed observatories. There must also be astronomers that possess great intellectual powers to explain the import and mutual relations of the observed facts. Nor is astronomy singular in this respect; for any science, the two things that are essential are facts and ideas, and the development of any science needs clear vision and deep thought. Science is the interpretation of nature, and therefore needs both the interpreting mind and nature for its subject. Science advances when clear, acute, logical thought is applied to accurately known and clearly conceived facts. That subtlety of intellect alone cannot create science is shown by the failure of the Greek schools of philosophy, with all their perfection of demonstration and method, to make any advance in physical science. Nor does the mere observation and knowledge of facts constitute science; and the Red Indian, of whose powers as an observer of nature Fenimore Cooper is such an enthusiastic admirer, made as little progress in science as the Greek philosophers or the schoolmen of medieval Europe. Since science, then, can be advanced only by clear ideas grappling with distinct facts, it is evident that every physical science demands the services of skilful observers and profound thinkers.

Occasionally there is a man so gifted that he renders distinguished services to science in both capacities; but there have been

many men who made large contributions to the advancement of science whose work was altogether confined to one of these departments. In a previous article we drew a striking contrast between Copernicus and Tycho Brahe. After the long night of the dark ages the first impulse to modern astronomy was given by the speculations of Copernicus, who could never have accomplished anything as an astronomical observer. But in order that his theories should be confirmed or amended, it was necessary that there should be accurate observations by which to test the theories; these observations were made by Tycho Brahe, whose skill has been the admiration of succeeding astronomers. On Tycho's death, however, the whole result of his life work was a great accumulation of records that bore as much resemblance to a science of astronomy as a heap of bolts, cranks, tubes, and wheels bears to a locomotive. As that heap of parts can become a locomotive only by suitable arrangement by intelligent mechanics, so Tycho's records had to wait until there should arise an interpreter of them before they were really of any scientific value. This interpreter came in the person of John Kepler, who has been well called "the legislator of the stars," as Tycho may very appropriately be called "the shepherd of the stars."

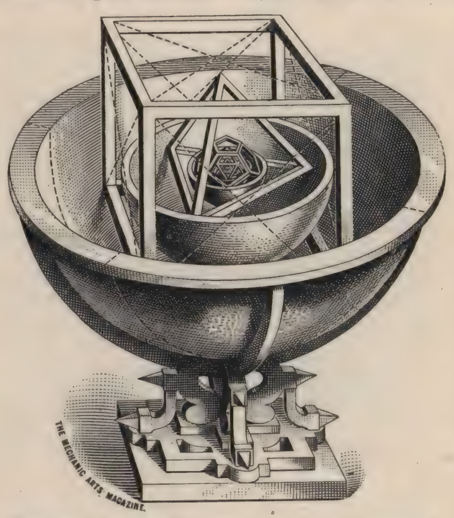
JOHN KEPLER.

John Kepler was born on December 27, 1571, at Weil, in the duchy of Würtemberg. His father was an idle and shiftless tavern keeper, and our hero was taken from school in his ninth year, to serve as a potboy in the tavern. His childhood was rendered still more miserable by an ignorant and ill-tempered mother. When the lad was four years old he had a severe attack of smallpox, which left him with weak eyes and an impaired constitution. Since he was thus disqualified for the active duties of life, it was thought that he was fit only for the church, which was the only profession that then offered intellectual employment. At the age of seventeen he entered the university of Tübingen, which was then one of the great centers of Protestant theology. In the university the Ptolemaic system of astronomy was still taught in the regular professorial lectures, though the professor of mathematics privately taught Copernican principles. During his residence at the university, Kepler's preferences leaned towards the church, but when the professorship of astronomy at the university of Gratz was offered to him, he accepted it in compliance with the wishes of his friends.

The duties of the chair of astronomy included the prediction of the fates of individuals and nations, as well as the calculation of eclipses and the movements of the heavenly bodies. Kepler, indeed, was an enthusiastic student of astrology, and thought he found in his own life strong confirmation of the doctrine that human affairs are regulated by the aspects of the planets. A large part of his income was derived from the publication of almanacs containing prophecies; some lucky weather predictions in his first almanac gave him a good reputation as a weather prophet. Though he had some faith in astrology, yet it cannot be doubted that he cultivated it chiefly as a means of replenishing his ever-needy exchequer; for he says, "Nature, which has given to every animal some means of supporting life, has designed astrology as the ally and adjunct of the astronomer," and in the preface to the Rudolphine Tables he says: "Astrology, though a fool, is the daughter of a wise mother."

In the beginning of his book, "The Mystery of the Universe," he says: "In the year 1595 I brooded with the whole energy of my mind on the subject of the Copernican system. There were three things in particular of which I sought the causes why they are not other than they are: the number, the size, and the motions of the orbits." The ancients, who held the Ptolemaic system, assigned reasons why there should be seven, and no more than seven, wanderers.

It seemed to the ancients that there ought to be seven wanderers in heaven to correspond to the seven windows in the human head: in the head there are two eyes, two ears, two nostrils, and a mouth; so in heaven there are two favorable stars, two unfavorable stars, two luminaries, and Mercury, which is indifferent. Kepler tried to find some equally convincing reason for the existence of six planets in the Copernican system; he sought for this reason in the occult properties that the ancients believed certain numbers to possess. A number that is equal to the sum of all its factors is called a *perfect* number, and perfect numbers were supposed to have wonderful mystic properties. Now $6 = 1 \times 2 \times 3 = 1 + 2 + 3$, so six is a perfect number, and Kepler fancied that this was the reason for the existence of six planets.



KEPLER'S SCHEME REPRESENTING THE PLANETARY SYSTEM.

In searching for a geometrical relation among the distances of the planets from the sun, Kepler at first resorted to plane geometry, and endeavored to find the desired geometrical relation by inscribing regular polygons in a circle. After incredible labor in calculation he became convinced that no definite relation among the orbits could be found in this way; but he remembered that, while there is an unlimited number of regular polygons, the Greek geometers had proved that there can be only five regular solids, and he imagined that the five regular solids must correspond to the spaces between the planets. He lays down the law thus: "The orbit of the earth is a great circle of a sphere, which is the norm and measure of all. Round the earth's sphere describe a dodecahedron; the orbit of Mars is a great circle of the circumscribing sphere of this dodecahedron. Round the sphere of Mars describe a tetrahedron, and Jupiter's orbit is a circle of the sphere circumscribing it. Describe a cube about Jupiter's sphere, and a circle of the circumscribing sphere of the cube is Saturn's orbit. An icosahedron inscribed in the earth's orbit gives the orbit of Venus; and an octahedron inscribed in the sphere of Venus gives Mercury's orbit."

Kepler proved that the radii of these six spheres are approximately proportional to the distances of the planets from the sun. Bursting into a rhapsody he writes: "The intense pleasure I have received from this discovery can never be told in words. I tired of no labor, I shunned no toil, I spent days and nights in calculation to see if my hypothesis would agree with the orbits of Copernicus." This discovery, though of no value itself, was destined to lead to very important results at a later period, and the immediate effect of its publication was to bring Kepler to the favorable notice of Tycho Brahe and Galileo. Kepler visited Tycho at his observatory and Tycho offered him the post of mathematical assistant; but Kepler declined the offer, saying, "for observations my eye is dull and for mechanical operations my hand is awkward."

At the age of twenty-six Kepler married an heiress of twenty-three, who, though young in years, was old in matrimonial experience, and had been divorced by her former husband. His married life was unhappy; he suffered much from poverty and sickness, and in 1611 his wife died of low fever, brought on by want. His second marriage took place in 1613, and he has left a detailed account of the selection of his bride in a very remarkable letter, in which he discusses the merits and demerits of eleven ladies whom he alleges to have been candidates for the vacant place in his heart and home. His choice fell upon a poor orphan girl, and it is pleasing to read that the marriage proved exceedingly happy. In arranging for a supply of wine for his new household, he had a dispute with the wine merchant, which led to the publication, by Kepler, of a tract upon the gauging of casks with curved sides; in this tract he laid the foundations of what mathematicians call the "Method of Infinitesimals."

(*To be Concluded.*)

CURRENT TOPICS.

Mrs. Frederic R. Honey.

The White Man's Burden.

Take up the White Man's burden—
  Send forth the best ye breed—
Go, bind your sons to exile
  To serve your captives' need;
To wait, in heavy harness,
  On fluttered folk and wild—
Your new-caught sullen peoples,
  Half devil and half child.

Take up the White Man's burden—
  In patience to abide,
To veil the threat of terror
  And check the show of pride;
By open speech and simple,
  An hundred times made plain,
To seek another's profit
  And work another's gain.

Take up the White Man's burden—
  The savage wars of peace—
Fill full the mouth of Famine,
  And bid the sickness cease;
And when your goal is nearest
  (The end for others sought)
Watch sloth and heathen folly
  Bring all your hope to nought.

Take up the White Man's burden—
  No iron rule of kings,
But toil of serf and sweeper—
  The tale of common things.
The ports ye shall not enter,
  The roads ye shall not tread,
Go, make them with your living
  And mark them with your dead.

Take up the White Man's burden,
  And reap his old reward—
The blame of those ye better,
  The hate of those ye guard—
The cry of hosts ye humour
  (Ah, slowly!) toward the light:—
"Why brought ye us from bondage,
  Our loved Egyptian night?"

Take up the White Man's burden—
  Ye dare not stoop to less—
Nor call too loud on Freedom
  To cloke your weariness.
By all ye will or whisper,
  By all ye leave or do,
The silent sullen peoples
  Shall weigh your God and you.

Take up the White Man's burden!
  Have done with childish days—
The lightly-proffered laurel,
  The easy ungrudged praise:
Comes now, to search your manhood
  Through all the thankless years,
Cold, edged with dear-bought wisdom,
  The judgment of your peers.

(*By Rudyard Kipling; by permission of McClure's Magazine.*)

This poem, "The White Man's Burden," saw the light in February of the current year. When it was written, the treaty of peace between the United States and Spain was before the senate for discussion, and the question of the ownership of the Philippine Islands was still undecided. Powerful arguments had been made for and against their acquisition by the United States. The "ayes" dwelt on the naval and commercial value of the archipelago, and on the prestige which the country would gain by such an enlargement of her domain; the "nays" pointed to the Constitution of the United States, and urged the nation to consider the expense attending the occupation of such distant territory, the cost of the necessary fleet and garrison for its defense, and the uncertainty of pecuniary profit. Rudyard Kipling's strong and forcible verses were pitched in a higher key; he ignored all questions of national gain or loss, but brought home to many a waverer the conviction that there lay before this country a duty—an opportunity; should she take it or leave it? It might or might not bring tangible recompense, but was that to be the first consideration? Duty is its own reward. "Am I my brother's keeper?" is a question as old as the story of the human race; and Rudyard Kipling answered it with an emphatic "Yes!" when he wrote "The White Man's Burden." He has written better verse, but nothing that appeals more strongly to the instincts of manliness, courage, and self-sacrifice.

"The White Man's Burden!" The phrase caught the people's ear, and touched the people's heart. In these few words Rudyard Kipling has created for himself a monument which may endure when all else that he has written is forgotten. He sums up in them the history of centuries that are past, and prophecies of centuries to come. He speaks as a prophet speaks, warning and exhorting; he stands at the parting of the ways, and

points a kindred nation to a toilsome road, leading to a very distant goal, to be attained not by the workers of today, but by future generations, who will call their forefathers to account if the work of today is ill done.

America has unexpectedly become responsible for the government of the Philippine Islands; the obligation has been forced upon her by a combination of circumstances which could hardly have been foreseen. In contemplating the task which lies before her, if the White Man's burden is to be borne bravely and patiently, it is natural to institute a comparison with the countries in which her Anglo-Saxon kindred have done and are doing similar work. Great Britain rules "dark peoples" on two continents; but Kipling had in mind India, in which much of his life has been spent, rather than Africa, when he wrote the verses which are so pregnant with meaning for Americans at this juncture; and as India and the Philippines are tolerably near neighbors, the experiences of the White Man in the two countries may correspond in some points, notwithstanding the difference in their circumstances.

America comes into possession of the Philippines as a whole; Great Britain acquired her Indian empire very gradually. Close commercial relations had been established for many years before there was any thought of conquest. Just 300 years ago the East India Company began to trade at Indian ports. As years went on the company came into collision with the trading interests of other European nations; the battles of Europe were fought on Indian soil, with the help of native troops on both sides. One after another great tracts of country came under British control. The control was that of a private company, acting under the authority of charters granted by parliament; but forty years ago the company ceased to exist, and its powers and rights were transferred to the British government.

The responsibility of America for the Philippines falls to her in different fashion. Her commercial relations with the islands were quite insignificant. She seems to seize them by force, yet it may more truly be said that they are thrust on her by the inexorable logic of circumstances. White men and white men's methods are not strangers there. The Filipinos have had glimpses of modern civilization, and parts of the islands have had experience of a government which uses its dependents for its own purposes. What manner of men is America going to send there to regulate the civil affairs of the country when the work of the soldier has been done? No one who goes in hope of a life of ease, or to seek a "fat place," can ever make his mark, or raise the islanders' standard of life, and thus really bear his share of the White Man's burden. Such work is done by self-sacrifice, unconscious it may be, but always real.

Kipling's suggestive phrase puts the work of the conquering White Man in the East in a very different light from that in which it is usually shown. What is this burden which is to be borne by him? He who is a civilized, self-restrained, self-governing human being, the product of a favorable environment for many generations, is called on to use the powers with which he is endowed for the benefit of the millions of the East whose racial development seems to have been arrested. He is placed on a higher level than the greedy fortune hunter who passes his life among strange scenes, in the midst of a subject people, only for the sake of what he can gain from them; he goes primarily to make a living and a place for himself in the world, it is true; but he earns that living and that place by honest hard work for the people among whom his lot is cast, with small thought of self and with resolute courage. He has to teach them to rule and govern themselves; he must bear with the weakness and vices of the "new-caught, sullen peoples, half devil and half child," the product of generations of oppression, wrong, and cruelty. He must teach them that a White Man, worthy of the name, never "says the thing which is not"; that his eyes and ears are always open; that he puts his own hand to work for the people whom he rules; that he will protect the weak and aid the suffering; that law will be fairly and justly administered; that crime will be punished, by whomsoever committed; that taxation shall not be extortionate; that customs, persons, and property shall be respected; and that, according to the old Saxon phrase, every man shall be "law-worthy." Exactly in so far as he conforms to such an ideal will he bear his share of the White Man's burden. The "silent, sullen peoples" will learn such lessons only from those who live among them and become their friends. The lessons are costly to the teacher; every such pioneer goes with his life in his hand; and if the story of India is to be repeated on a small scale in the Philippines many will pay the price by disease or by violence before their work has produced visible results.

The material works which await the White Man's hand in the old countries where the applications of modern science are unknown hardly need enumeration; they suggest themselves to every mind. But how will they be received? The harbors, the roads, the railways, the bridges, the telegraphs, promoting easy communication, and the canals for irrigation, or the works which shall protect lowlands from floods, will be recognized as of value; they will be tolerated, and in time will be welcomed by the people. They will see also that it is for their good that robber bands are swept away, and that the wild beasts which terrorized their villages are gradually exterminated. But when there is interference with their established customs, the killing of the aged or of infants, or the burning of their widows, they murmur and rebel. Or when the White Man tries to "fill full the mouth of famine, and bid the sickness cease," he will find his earnest endeavors checked by the dark peoples' customs and beliefs; the food which he provides will be unacceptable, the methods employed by modern sanitary science will be accounted sacrilegious; and the would-be benefactors must begin at the beginning again, and invent new methods which, next time (for there is always a *next time* to famine and pestilence in the East), may accomplish the work without outraging the feelings of the sufferers.

And meanwhile, the neighbor nations will stand by, observing and publishing all the failures and mistakes, giving little credit to the hard-won partial successes of those who are doing the work. Yet however thankless the task, the voice of one who knows reiterates the call:

> Take up the White Man's burden,
> And reap his old reward—
> The blame of those ye better,
> The hate of those ye guard.
>
> * * * * *
>
> By all ye will or whisper,
> By all ye leave or do,
> The silent, sullen peoples
> Shall weigh your God and you.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION FOR 1897.

THIS interesting and instructive volume, which is issued by the Government Printing Office, Washington, D. C., consists of two parts. The first part is the report proper, and deals with the work of the Institution, expenditures, appropriations, buildings, funds, administration, and other matters of little interest to the general reader. We must mention, however, the account given in the report of the publications of the Institution, which, for the year in question, aggregated nearly 10,000 pages, "covering to a greater or less degree nearly all branches of human knowledge." A very important contribution of the Institution to scientific literature was a "Catalogue of Scientific and Technical Periodicals," containing the titles of more than 8,500 technical and scientific periodicals in all languages.

Worthy of notice is, also, the ethnological work of the Institution, which has for some years past been recognized as the most reliable source of information, with respect to the customs, religion, languages, traditions, and actual conditions of the American Indians. The Institution devotes a large sum to this kind of research, and has in its service some of the most distinguished specialists in the country.

By far the most interesting part of the Report is the "General Appendix," which consists of several essays written by the foremost scientists of the time, on almost all subjects that are of either importance or interest to the student of natural science. This part comprises about 600 pages. The essays, which deal with astronomy, chemistry, physics, physiology, mechanics, geology, meteorology, biology, botany, etc., are written in untechnical language, by men that are masters of the subjects they treat; the result being a collection of valuable information, from the reading of which much pleasure and instruction may be derived. Space does not allow us to make even a brief review of these essays; but we shall call attention to a few points that may be of interest to our readers.

Mr. G. H. Darwin gives a very clear explanation of the action of the moon in producing the tides, and the effect of the latter in retarding the rotation of the earth, and shows us that in the distant future there may come a time when the day and the

month will be of the same duration; that is, when the earth will revolve on its axis in the same time occupied by the moon in revolving about the earth. This day and month will contain 55 of our present days.

Mr. Elihu Thomson writes on "Electrical Advance in the Past Ten Years." Referring to the many things accomplished by electricity, he says: "That paragon of nature, the diamond, can now be fashioned in an electric crucible from plain black soot." Mr. W. Crookes will soon explain to us how this is done. It is surprising to see how new almost all electrical inventions are, how fast they have developed, and how perfect they have become. The telephone dates from 1876. As for electric locomotion, Mr. Thomson says that "at a convention of street-railway men, held so recently as 1887, a discussion of electric traction as applied to horse railways was vigorously criticised as a waste of time which might have been better applied to practical subjects, instead of to such a fanciful or theoretical one. In fact, the contention was that the care and feeding of horses should take precedence of so unimportant a subject as electricity."

There is a most interesting article and several brief notes on the X-rays, written by Dr. W. C. Roentgen, the discoverer of this wonderful manifestion of electrical energy.

Mr. S. P. Langley, the great expert on "Mechanical Flight," writes on this ever-fascinating subject. Especially worthy of notice is the historical sketch he gives of his experiments and inventions, of his unsuccessful trials and his failures, which, bringing to disappointment what he had thought well-founded expectations and hopes, often discouraged him and almost deterred him from continuing work so unpromising. But his patience and perseverance—great and rare qualities, without which no inventor can hope to succeed—overcame all obstacles, and his last inventions, which he calls *aerodromes*, and describes in this article, have done much towards the solution of the vexed problem, "How can we fly?" Intimately connected with this problem is that of the flight of birds, which is very ably discussed in an article "On Soaring Flight," by Mr. E. C. Huffaker. The facts and experiments he describes are most interesting—some of them most curious.

Among other things relating to "Diamonds," Mr. William Crookes gives a good description of the laboratory production of the precious stone. The principle is comparatively simple. Pure iron is placed in a crucible with fine charcoal, and heated by an electric arc to about 4,000° C. The iron, of course, melts, and the carbon of the charcoal is dissolved in the molten metal, just as sugar in water. The whole mass is now plunged into cold water, which almost instantly solidifies the outside of the molten mass, thus forming a thick and rigid crust, preventing the remaining portion from expanding. Now, as this portion solidifies, it tends to increase in volume, and as this is prevented by the solid crust, an enormously high pressure results, under which the dissolved carbon separates in the form of brilliant crystalline fragments — perfect diamonds. Such diamonds, however, are exceedingly small (the largest one ever made being less than .04 inch in diameter), and the process of manufacture exceedingly expensive.

To those who take special pride in calling themselves "practical men," and who, "exercising the prerogative of ignorance," speak with contempt of the "theoretical man," we recommend Mr. J. J. Stevenson's admirable article on "The Debt of the World to Pure Science," where they will learn that, while the theoretical man does not concern himself much with dollars and cents, bread and butter, he has invariably furnished the material out of which wealth, civilization, and prosperity, as understood by the "practical man," have grown; and that the said "practical man," in his disparagements of pure science, shows at once his ignorance and his ingratitude.

There is an essay by Lord Kelvin (formerly Sir William Thomson) on "The Age of the Earth as an Abode Fitted for Life." His object is to refute the assumptions of some geologists who hold that the earth has been the abode of living beings during hundreds and perhaps thousands of millions of years past. From physical considerations, he concludes that the age of the earth, in its present form, cannot be much, if at all, above 24,000,000 years. The reader, however, must not take such figures and computations as relate to these remote periods very seriously. They are all founded on more or less plausible, more or less objectionable hypotheses; and, what is worse, they are usually the results of investigations undertaken with the object, explicit or tacit, of either substantiating or discrediting the biblical accounts of creation (for, notwithstanding our boasted scientific spirit and impartiality, we have not yet become sufficiently hardened or unfeeling to exclude venerable theology from our investigations).

ROASTING AND BAKING AS A FINE ART.

W. M. Brown.

A Novel Way of Roasting or Baking Meats: Seasoning From the Inside Outwards. How to Obtain Boneless Shad.

TO THE truly scientific mind there is nothing too insignificant for the most careful examination and painstaking experiment. Among the many things that Count Rumford made subjects of research there will be found almost all that pertains to the kitchen; the making, the maintaining, and the using of culinary fires, stoves, and chimneys, the art of cooking, and almost everything connected therewith. And this scientist not only investigated these

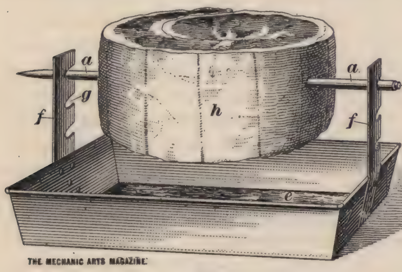


Fig. 1.

things theoretically, but, at great expense and labor, experimented with them practically, and, what is better still, wrote copiously on them, as he did on everything else he investigated, leaving a store of useful knowledge from which posterity may draw for all time. There is no cook or chef of today who may not with great profit read his works.

Happily it is now the fashion for many of our popular periodicals to devote more or less space to these very subjects; indeed, no publication that hopes to win and maintain a place in the household can afford to entirely neglect them. In the March number of this magazine there appeared an article by Mrs. Henry Esmond on roasting, broiling, and baking, which was both instructive and entertaining.

While not professing to be a chef, nor to being possessed of any wonderful amount of knowledge on the subject of cooking in general, the writer desires to present what he believes will prove to most of the readers a new method of roasting or baking meats.

Having a properly heated oven and a baking piece to prepare, we next need a properly arranged dripping pan. Fig. 1 shows one, in which *a* is a steel spit, or rod, resting in upright sheet-iron brackets *f* riveted to the ends of the pan, and having notches *g* in which the spit may rest or turn; *h* is the meat resting over the pan *e*, with the spit thrust through it. When so arranged, the meat may be turned with ease whenever desired.

Now, the spit *a* is more than a simple rod, as shown in Fig. 2; it is hollow—a tube, in fact—with holes at about the middle of its length that run crosswise of the spit and communicate with the central bore *c*; one end is drawn down to a sharp point, and the other end is stoppered by a plug *d*. This spit should be about $\frac{1}{2}$ inch outside diameter, and made by drilling a $\frac{5}{16}$-inch hole into the rod for about half its length, and the holes *b* should be about $\frac{1}{4}$ inch diameter.

The meat should be so spitted that the openings *b* are as nearly in the center of the meat as possible; and the notches in the side brackets should be a trifle higher on one side than the other, so that the spit can be placed in a sloping position with the plugged end a little higher than the pointed end. This insures the seasoning getting into the meat. A dripping pan so prepared, and the spit so arranged, costs but a trifle. Prepare the meat for baking, but do not use any salt or other seasoning

Fig. 2.

on the outside of the meat. When the spit has been thrust through the meat, practically as shown in Fig. 1, draw the plug *d*, which may be of wood, and place in the bore as much salt, pepper, or other seasoning as is deemed necessary to season the meat, and ram it well to the bottom of the hole and replace the plug tightly. Place the pan and contents in the oven. The result will be that the heat of the oven will sear over the outside of the meat, closing the pores and thus preventing the escape of

the juices, and the spit, becoming hot, will sear the meat where the spit enters it, and thus but very little juice will escape around the spit.

As the heat strikes inwards the juices will enter the holes *b* in the spit and will mix with the salt and other seasoning, and the liquid thus formed will permeate the entire body of the meat, acting and striking out from the center, thus seasoning it from the center outwards, instead of from the surface inwards, as is the case when the seasoning is applied to the surface. It will be evident that the seasoning, being in the center of the meat, cannot be dried into a crust and caused to but partly perform its work, as is always the case when it is applied to the outside of the meat. Being thus free to disseminate itself in every direction, without becoming dried or crusted, and having no hard outer crust to penetrate, the meat will be seasoned with absolute uniformity throughout, and will have a flavor impossible to obtain by the usual manner of seasoning.

After the meat has become seared over, place in the dripping pan such fats, as suet, butter, or dripping, as may be desired, and baste the meat occasionally to prevent the outer surface from becoming dry and hard. If a true roast is desired and the fire is properly arranged for it, the dripping pan may be set before the fire and the meat turned as is ordinarily done in the process of roasting.

The spit is easily kept clean inside by the use of a wire with a swab at one end, and if laid away in a dry place will nôt rust. Be sure to keep the holes *b* open, as they will tend to become choked.

It is believed this method of roasting or baking meats will be new to most readers, and it is too much to hope that it will become generally adopted. The difficulty will be that it is something new and requires preparation, and, at first, some little attention to detail. These are the stumbling blocks in the way of the great majority of female cooks, not with the professional ones so much as with "milady" who attends to her own culinary affairs. The ordinary time-serving servant, will never mend her ways unless the mistress forces matters, and this she is loath to do. The only reason why male cooks take precedence in cookery is due to the abnormal conservatism existing among women. To think for themselves and branch out into untried fields seems to have unnecessary terrors for them.

Once a certain manner of doing a thing is acquired, any suggested change is unheeded. It is sometimes lamented that young ladies do not learn cooking at home from mother, and that they prefer to play the piano or amuse themselves in any manner that comes to hand. The fact is, it is oftener a blessing in disguise, for once a particular style of cooking is acquired nothing can change it, especially if acquired when quite young, and mother's unscientific and faulty methods are perpetuated for years, to the discomfort of all who depend upon the daughter for the pleasures of the table. It is far better that correct knowledge be attained after the young woman has arrived at maturer years, than that wrong notions be inculcated in early youth, from which her natural conservatism will prevent her from departing.

The writer once induced a lady to prepare and cook a shad in the following manner: Clean the fish; lay it upon its back, and with a sharp knife cut on each side of the backbone down the whole length of the fish, deep enough to sever the ribs from the backbone. Place the fish on its back in an earthenware dish large enough to allow of its lying at full length, thus exposing the two incisions. Pour over the fish sufficient strong cider vinegar to cover it and let it remain for from two to four hours. Broil or fry in the usual manner.

The first objection raised was that the result would be a pickled fish for dinner, but when assured she would have nothing of the kind, she tried the experiment. To her utter surprise, when the fish was eaten, she had a boneless shad, the flavor not being in the least disturbed by the pickling process. The acid in the vinegar had simply turned the troublesome bones to a chalky consistency and they could not be detected when eaten. Although the experiment was an absolute success, she has never repeated it. Why? Oh, she didn't like to be trying new things, the old way was good enough, and bone mining has gone on ever since when she has had shad for dinner. This is the delirium tremens of conservatism.

The culinary art, like any other, would become interesting, and cease to be the drudgery it is, if cooks would study and think, instead of following obsolete ways, simply because they were the ways learned in early youth. Considering the importance of the subject, it is surprising how little is known by the general public about cooking. There are plenty of faultfinders if a meal is not just what it should be, but comparatively few who know anything about cooking.

GOOD SCHEMES

LAYING OUT GEAR-TEETH.

W. H. Booth, London, England.

Mr. Harland Tuttle's method of laying out gear-teeth, as described by him in the Good Schemes of your April number, is particularly interesting to me because it is almost identical with one that I learned and practiced in my apprentice days. At the same time it is far from common to find patternmakers using this absolutely correct system. In place of sheet zinc, we were accustomed to use a piece of tinned plate, which we brought to a dull dead surface by rubbing with fine sandpaper. Having described the various curves, we employed them as grinding templets, to which we fitted the cutters. The cutters were then fixed in the revolving spindle of the dividing engine. Our dividing engine was a large machine on which we turned up the blank patterns and got all ready for dividing. On the spindle that carried the pattern to be cut, there was a wheel of 360 carefully cut teeth, and it was arranged with a number of change gears so that we could cut wheels of any number of teeth. Our wheel patterns were thus very accurate, and truly pitched. The revolving cutters finished the teeth, except for a final sandpapering. Mr. Tuttle, in his article, omits one little detail that we practiced, namely, the putting in of fillets at the junction of the teeth with the rim. It is common to see these left sharp, not filleted at all, as shown in Fig. 5; again, others put

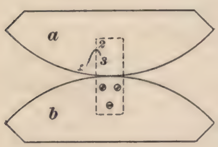


Fig. 1.

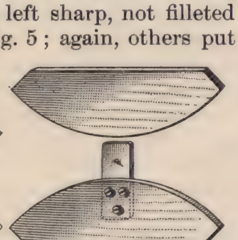


Fig. 2.

in circular fillets. The latter neither looks well nor is it correct. I have seen such circular fillets put in so much too full that the points of the teeth of each wheel touched on the fillet and had to be filed off. The fillets ought to be just as correctly shaped as the rest of the tooth curve, and this can best be done in the following manner: In Fig. 1, *a* and *b* are two rolling circles of the pitch diameters of the respective wheels. To one of these, *b*, a projecting piece is attached, as shown in Fig. 2, and this is furnished with a point, at a distance from the curve equal to the distance that the tooth projects beyond the pitch line. If *a* and *b* are now rolled together in firm contact, the scribing point draws a curve *1 2 3*, as shown. The part of

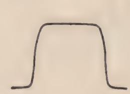


Fig. 3.

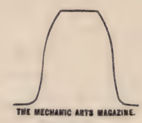


Fig. 4.

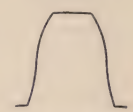


Fig. 5.

this curve between *1* and *2*—from *1* to its lowest point—is then an appropriate form of fillet for joining the curve of the flank of the tooth to the rim of the wheel, as in Fig. 4. In a set of wheels, of course, exact opposites cannot be employed for this purpose, but that curve must be selected which will give the strongest tooth without contact at any point being possible. If the largest wheel and the smallest of a set clear each other, all the others of the set will do so. Not only should there be a properly formed fillet at the base of the tooth, but it would be good practice to take off the very sharp edges at the point of the tooth, as shown in Fig. 3; in England, this is done now on large wheels by all the best makers. Fig. 3 also shows the new form of tooth (as regards *length*) now recommended in place of the old form of Figs. 4 and 5. This shortening of the tooth adds much to its strength, and the wheels run every bit as smooth; it has been adopted by some of the best concerns in England and America, and should be strongly advocated by those interested in gearing.

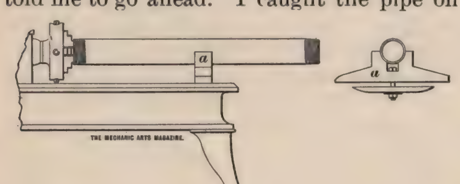
Here I would like to say something about the keying on of gear-wheels and wheels in general. For years I have followed the system that was first adopted, I believe, on the Porter-Allen engine, and I have never known it to fail, though I have had endless trouble convincing some men of its merits. As is perhaps known, the method consists in boring the wheel to the same diameter as the shaft, and then shifting the wheel about $\frac{1}{32}$ inch out of center and reboring to the same diameter, thus cutting a thin crescent out of one-half of the hole, and then putting the key in at this side, thus drawing the

opposite side of the hole hard against the shaft, thereby fixing the wheel absolutely and truly central. Because the wheel (before keying) is loose on the shaft, the non-informed man declares it is impossible to fix it with a key so as to run true. He thinks he knows it all, but the fact is he does not see that, while with the old system the wheel and shaft are in hard contact along two lines only (namely, at the key and diametrically opposite), with the new system the wheel and shaft are in hard contact at the key and *half way around the circle on the opposite side.* Of course, where a wheel is bored small and then pressed on, there is contact all around the bore, and this is the best job; but then, such a fit is not practicable in ordinary work, where the wheel may require removal away from shop facilities, and then the method described should be used.

TO THREAD A LONG PIPE IN A SHORT LATHE.

R. H. Hampson, Armiston, Ala.

THE SCHEME described here will, I think, be of interest to some of the readers of THE MECHANIC ARTS MAGAZINE. A 6-inch pipe on the boilers at our works was leaking; the engineer and the foreman of the machine shop decided that, if two new threads were cut farther back on the pipe, the leak would be stopped. The foreman said that unfortunately the new thread could not be cut in our shop, as the pipe was 9 feet long and our lathe was only 5 feet between centers; and we had no pipe dies. I told the foreman that, lathe or no lathe, I could cut it, and he told me to go ahead. I caught the pipe on

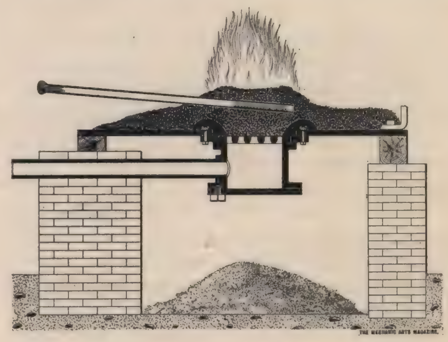


the inside by the chuck jaws, as shown in the enclosed sketch, letting the pipe stand away from the chuck so as to give clearance for the tool; I made a wooden steady rest, as shown at a, the one belonging to the lathe being too small, and bolted it to the bed with the anchor plate belonging to the lathe rest. I trued up the pipe and chased the threads up against the chuck, and made a good job of it too. Since then I have chased a good many different sizes and lengths of pipe in the same way.

FOR BLACKSMITHS.

E. O. Hurts, Schenectady, N. Y.

I RAN ACROSS the following good scheme in a blacksmith's shop some time ago, and it may help out some who have to temper reamers, bits, close-coil springs, and the like: Take a piece of pipe of suitable diameter



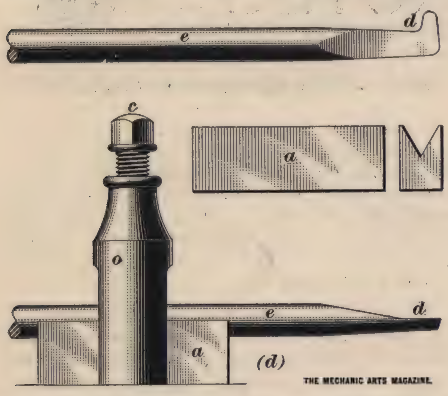
and convenient length, and place inside it the tool to be tempered; now plug up the farther end with waste, to prevent the hot gases from the fire from passing up and through the tube; all somewhat as shown in the accompanying sketch. By this simple means, the pipe is kept cool as long as one cares to use it.

A USEFUL BORING TOOL.

J. Breslove, Toronto, Ont.

THE GREATEST drawback of the old-time boring tool is the tremendous amount of forging required, and the necessity of having various lengths to correspond with different sizes and lengths of holes. I here give description of a lathe boring tool that does not require one-tenth the forging of the ordinary tool, and the same tool may be used for any length of hole, as the tool may be so shifted that there is no necessity for any undue spring. The dimensions given are for a tool to be used on a 16-inch lathe; for other lathes, make in proportion. Take a piece of ordinary machinery steel, about 3 in. $\times$ 1 in. $\times$ $\frac{5}{8}$ in., see a in the figure, and on the $\frac{5}{8}$-inch face, cut in it as shown a 60° V way; this block a is then the holder for the tools, and may be used for any size from $\frac{1}{8}$ to $\frac{3}{4}$ inch. Now take a piece of $\frac{1}{2}$-inch round tool steel any desired length and forge the end in the ordinary way for a boring tool, as at d. If the hole to be bored is smaller than $\frac{1}{2}$ inch, use smaller size of steel to suit. This is all the making that is

required in this tool. To use: put the block *a* in the tool post holder *o*, as shown at (*d*), lay tool in the **V** groove, and tighten setscrew *c* on to it. Let the tool project beyond



the block *a* only a trifle more than the depth of the hole to be bored; thus all unnecessary spring is avoided. Threading and other tools can be held in the same block.

FOR DRAFTSMEN.

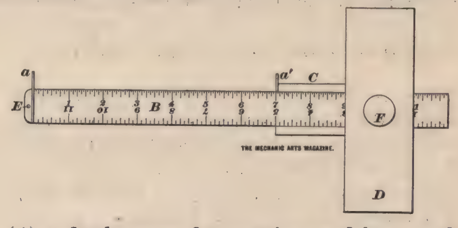
D. C. Walter, Toledo, Ohio.

THE FOLLOWING will be found a very convenient way of putting down and stretching paper for large drawings: After moistening the paper on the back in the usual manner, instead of turning up a half inch all around, tear some long strips of tracing cloth about 1 inch wide and coat one side of them with good heavy mucilage. Place the moistened paper in position on the board, and lay the strips of cloth around the edge, with one half over the paper and the other half on the drawing board; do this all round the edge of the paper. When dry it will be found that the paper is perfectly stretched, and the actual work of mounting is done in one-fourth the time required by the old way. The strips can be removed by simply pulling off, and can be used again.

A HAPPY COMBINATION.

Linwood C. Plummer, Fort Fairfield, Maine.

THE ACCOMPANYING sketch represents a home-made device, of my own construction, that I find useful in a variety of ways. Referring to the sketch, *B* is a graduated steel scale; *D* is a hardwood head, in which, and also in the sleeve *C*, the rule slides; *F* is a knurled-headed setscrew to hold the rule at any desired position. At *a*, brazed to the rule, is a strip of metal; at *a′* secured to *C*, is a similar strip; together these become (1) a *caliper*. With the rule extended to the right through head *D* the device becomes (2) a *try square*, and (3) a **T** *square*; while on the same side of the head, the device is also



(4) a *depth gauge*, for mortises and box work not exceeding 8 inches in depth. At *E* I fixed a hardened-steel point, and this converts the device into (5) a *marking gauge*. The tool has thus five distinct uses.

TESTING HELICAL SPRINGS.

Newark.

A FEW DAYS ago I was testing some large springs by closing them, coil to coil, in my bench vise. The third one broke and flew to pieces, one of the fragments passing dangerously near my head. I was in no hurry to test any more of them, until it occurred to me that, if I enclosed each spring in a piece of pipe a trifle shorter than the closed spring, I would be perfectly safe in any event. I did so, and though several of the springs broke, I was in no danger whatever, the pieces staying harmlessly in the pipe.

A LAMP SHADE.

Student.

A CONVENIENT lamp shade for any one engaged in reading or other close work at night can be quickly made, and at practically no expense, out of a square piece of paper or thin pasteboard — preferably of a dark-green color—fixed to the lamp by means of a piece of wire bent to the shape shown in the figure. That part of the wire passing through the paper can be bent so as to vary the angle of the shade and thus increase or decrease the amount of light thrown around.

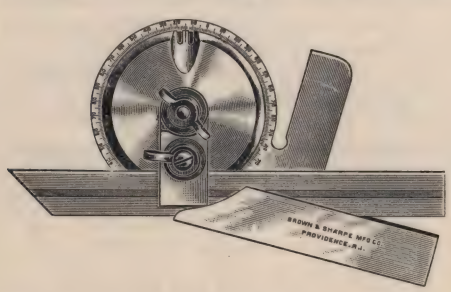
By passing the wire through the paper in the manner indicated, the paper is prevented from coming in contact with the chimney.

TRADE NOTES

A UNIVERSAL BEVEL PROTRACTOR.

THE ILLUSTRATION on this page represents the newly improved universal bevel protractor made by Brown & Sharpe Mfg. Co., Providence, R. I. This will be found a very convenient tool for use in any machine shop or manufactory; its uses as a protractor are practically unlimited, as the cuts on the opposite page go to show, these being but a few of its many applications. It is well adapted for all classes of work where angles are to be laid out or established, and, as the graduations on the dial are *accurate*, and all the alinements correct, *absolutely precise* measurements can be obtained. The workmanship, like that upon all tools turned out by the Brown & Sharpe Mfg. Co., is the very best of its class.

The dial is graduated in degrees entirely around the circle, and one-half and one-



quarter degrees can easily be estimated; it turns on a large central stud, hardened and ground, and when set can be rigidly clamped by the thumb-nut shown in the cut. The blades, which are about $\frac{1}{8}$ inch thick, can be drawn out to their full length and clamped independently of the dial. The graduation lines are below the surface, and are thus protected from wear. A feature that is of particular interest, and one that will be appreciated by draftsmen and toolmakers, is that one side of the stock is *flat*, thus permitting the instrument to be laid upon the paper or work. The blade usually supplied is 6 inches long, but a 12-inch blade can be furnished if desired. The price with 6-inch blade is $8.00; this in morocco case is $9.00. With 12-inch blade, the price is $9.00; in morocco case, $10.50.

BOOKS AND CATALOGUES.

THE STEAM ENGINE INDICATOR. Directions for the selection, care, and use of the instrument and the analysis and computation of the diagram. Compiled from the regular issues of "Power." With revisions and extensions comprising numerous tables. The Power Publishing Co., New York. Price, $1.50.

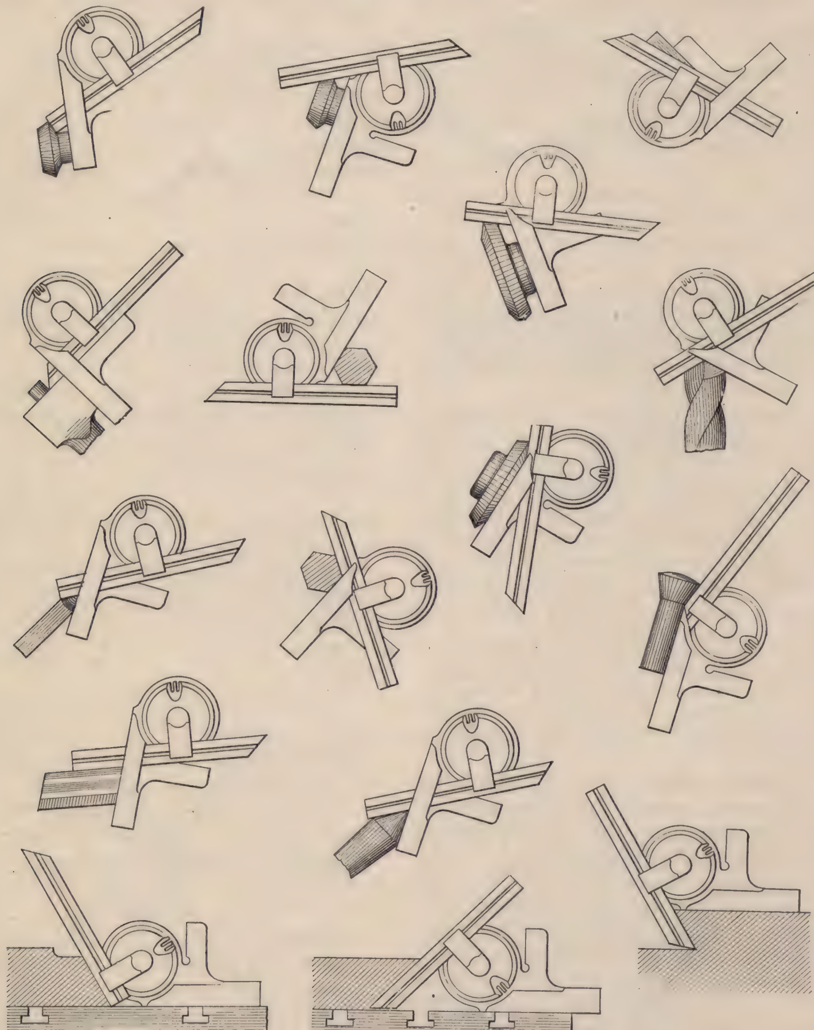
Of the many books that have been written on the steam-engine indicator the present one is probably best calculated to fill the wants of the practical engineer. It treats the subject in a thorough manner without being long-winded. It presupposes a certain familiarity with the indicator and its uses, therefore is not overloaded with a chapter describing the various makes, but starts off with an enumeration of the requirements of a perfect instrument, giving the reader advice to guide him in the purchase of an indicator suitable for his wants. The discussion of the diagram, its various parts, and the causes of their deviations from the ideal lines, is excellent. The planimeter comes in for its share in Chapter XII. Here, too, more importance is placed on the practical use of the instrument than on its theory or on the description of its various forms. A number of tables facilitating the work of computation, some of which we believe are original with the author, are given. Two chapters are dedicated to diagrams of compound engines, a subject not often found so well treated in books on the indicator.

We take pleasure in strongly recommending the book to students and engineers alike. Having given the author his dues, we cannot refrain from mentioning that the typographical execution of the work is not of the same standard, a fact that is regrettable, inasmuch as the figures of the tables are in many instances indistinct and in some places entirely obliterated.

BROWN'S MANUAL OF ASSAYING, eighth edition. Published by E. H. Sargent & Co., Chicago. 550 pages, 134 illustrations, with one colored scorifier plate. Price, bound in cloth, $2.50; in leather, $3.00.

Brown's Manual has gone through too many editions to need special introduction

to assayers or those interested in similar work. It has always been one of the best manuals on the subject for any person not wishing to go into the heart of the subject, as the manual does not introduce chemical equations or difficult mathematics, but has always been a plain, common-sense manual. mathematical and typographical errors that had been discovered in the previous editions, so that at present the book stands as a thoroughly tested and reliable manual on the subject it is intended to treat on. In the note upon this edition, the author, Mr. Walter Lee Brown, takes occasion to call



In glancing over the present edition it will be noticed that the general appearance and typographical work in the book is of a higher standard than most similar publications. The list of useful books more or less connected with assaying has been revised and brought up to date, and a careful investigation has been made to correct all of the

attention to the fact that Mr. Charles F. Chandler, of the School of Mines of Columbia University, New York City, deserves the credit for having devised and put into use the "Assay-Ton" system of weights, a system that has proved of such great use to all assayers, and which has always been described in Brown's Manual.

MECHANICAL MOVEMENTS, POWERS, DEVICES, AND APPLIANCES. Used in constructive and operative machinery and the mechanical arts. For the use of inventors, mechanics, engineers, draftsmen, and all others interested in any way in mechanics. By Gardner D. Hiscox, M. E. Norman W. Henley and Co., New York, publishers. Price $3.00.

This book contains a classified collection of all sorts of mechanical movements and combinations, good, bad, and indifferent. Its preparation must have been no small task, considering that it contains over sixteen hundred illustrations, each accompanied by a short description. There are 400 pages of it. There can be no doubt as to the utility of such a collection. It is to serve mostly, we take it, to give welcome suggestions for the solution of mechanical problems, to aid and stimulate, as it were, the inventive faculty. Taking the intention of the compiler to have been such, from his recommendation of the book to inventors, mechanics, etc., we cannot but feel that he has overshot the mark in some cases. Thus, we do not see the utility of a picture of a typewriter, or a bassoon, or any complete instrument, appliance, or machine. If, on the other hand, the book were intended to be a mechanical dictionary, it would be woefully lacking, as it then should contain ten times as much. But this is evidently not the author's aim. The book is certainly worth every penny of its price, and more, to whoever can make use of it.

NOTES ON DESCRIPTIVE GEOMETRY, WITH EXERCISES. By Prof. W. L. Aines, Worcester Polytechnic Institute. Third edition, 89 pages. Published by Moore & Langen Printing Co., Terre Haute, Ind. Price 50 cents.

The distinguishing feature of this little book is the large quantity of matter crowded into a small space. All the usual problems on points, lines, and planes, are given in the first sixty pages; the remaining thirty pages are devoted to the following subjects: tangent planes, sections, intersections of surfaces, development of surfaces, helicoidal surfaces, and the hyperboloid of revolution. The extreme brevity is largely due to the concise notation adopted. We quote one problem to show the style of presentation:

"PROBLEM 22.—*Given one projection of a line contained in a plane, to find the other projection.* Given the planes 1 and A^h, Fig. 50. This determines the H trace and H projection of the V trace of A. Since the V projection of the H trace lies in X, and the V trace lies in 1^v, A^v which contains these points is readily determined."

When one has mastered the notation employed—and this is an easy matter—these few words, in connection with the figure, give a clearer conception of the problem than the usual description of four times the length. Recognizing the fact that the third-angle method of projection is destined to universal use, the author has employed the third angle almost exclusively in problems and exercises. This feature will make the book peculiarly acceptable to draftsmen. A valuable feature of the book is the large number of exercises—206 in all; many of these are practical in their nature. As the name indicates, the book consists of notes originally prepared for students' use in the classroom. There can be no question that the book is well suited to classroom instruction; and while its conciseness may prove an objection to its use outside of the classroom, we believe that any one desiring to study the principles of descriptive geometry will do well to add the book to his library.

Copies may be obtained of Mrs. S. P. Burton, Rose Polytechnic Institute, Terre Haute, Ind.

NEW BOOKS OF INTEREST.

Any of which can be obtained from The Technical Supply Co., Scranton, Pa.

"Haswell's Mechanics' and Engineers' Pocketbook." Sixty-fourth edition. Chas. H. Haswell. $4.00.

"Machine Design." Part II. Forrest Jones. $3.00.

"Elementary Physics and Chemistry." R. A. Gregory and A. T. Simmons. 50 cents.

"Blackboard Drawing." Hints on sketching natural forms. W. E. Sparkes. $2.00.

"Practical Notes on Hydraulic Mining." Second edition. G. H. Evans. $1.00.

"Internal Wiring of Buildings." H. M. Leaf. $1.40.

"Sewer Design." H. N. Ogden. $2.00.

"Locomotive Engine Running and Management." Twenty-first edition; rewritten. Angus Sinclair. $2.00.

"Chemical and Metallurgist Handbook for the Use of Chemists." Pocketbook. J. H. Cremer and G. A. Bicknell. $3.00.

"Characters of Crystals." Alfred J. Moses. $2.00.

"Stars and Telescopes." Popular astronomy. D. P. Todd. $2.00.

"Massage and the Original Swedish Movements." Fourth edition; revised and enlarged. Kurre W. Ostrom. $1.00.

ANSWERS TO INQUIRIES

NOTE.—*Address all letters containing questions to be answered in this department to* THE MECHANIC ARTS MAGAZINE, *Scranton, Pa.*

1. *Put this address both on the envelope and at the head of the letter.*
2. *Only questions of general interest to our readers will be answered.*
3. *No questions will be answered by mail.*
4. *Drawings or sketches accompanying questions should be made on a separate sheet of paper, and should be drawn as clearly as possible.*
5. *The names and full addresses of the writers must accompany the letters, or no attention will be paid to them. Unless otherwise requested, we will publish only the initials and address of the writer.*
6. *Reference to inquiries previously answered should give date of issue and number of question.*
7. *Any book not out of print and for sale by regular dealers may be ordered through the Magazine.*

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(137) In HOME STUDY MAGAZINE, January, 1899, Answers to Inquiries, No. 546 (*b*), I find the following: "We know that the top of the wheel of a moving buggy goes faster than the bottom." Is this so? How can it be so, when the wheel is in one solid piece?

J. H., Crescentville, Ohio.

ANS.—The following will make it plain to you: Suppose the felloe and tire of the wheel to be removed, leaving the hub and the projecting spokes, as in Fig. 1. If the wheel in this condition is caused to turn, the motion is not exactly rolling, but a series of rotations about the ends of the spokes as they successively come in contact with the ground. Thus, as shown in the figure, the entire wheel is rotating

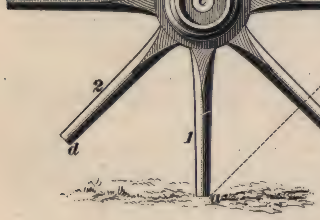

FIG. 1.

about the end *a* of the spoke *1*, which is the only point of the wheel in contact with the ground. In an instant the end *d* of spoke *2* will touch the ground, point *a* will be lifted, and the whole wheel will swing about point *d* as a center. Now, if there were twice as many spokes, the motion would be smoother; and if there were three or four times as many, it would be still smoother. In any case, however, the *character* of the motion would remain the same; that is, the motion would be made up of a succession of short swings about the ends of the spokes. Carrying the matter a little further, it is not difficult to see that a wheel with a rim might be conceived as having a very great number of spokes, the ends of which are very close together. This conception of the wheel with the rim leads at once to the following

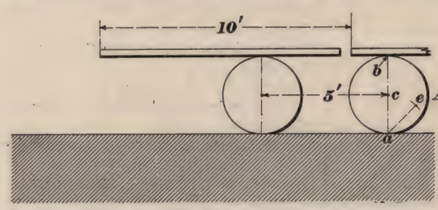

FIG. 2.

important fact: A rolling body rotates as a whole about the point in contact with the ground. Thus, the roller shown at *A*, Fig. 2, is swinging as a whole about the point of contact *a* just as truly as the wheel of Fig. 1 is swinging about the end *a* of the spoke. When a body rotates about a fixed point, or axis, it is easy to find how fast any given point is moving at any instant, and also the direction of its motion. For example, in Fig. 1, *a* is the fixed point; suppose the center *c* of the wheel to be moving 5 feet per second. The point *b* at the end of the upper spoke is twice as far from *a* as from the center *c*, and it is plain that it moves twice as far in the same time, or, in other words, moves twice as fast as the center *c*. The point *e* is about 1.4 times as far from *a* as from the center *c*, and hence it is moving about $5 \times 1.4 = 7$ feet per second. If we wish to find in what direction *e* is moving, we describe an arc of a circle through *e* with point *a* as a center. In the same way, the direction of motion of point *e*, Fig. 2, is determined. There is this difference, however: in Fig. 1, point *e* follows the circular path until the end *d* strikes the ground, while in Fig. 2 the circular arc is the path of the point for only an instant. The speed of any point of the roller of Fig. 2 is found as above shown; thus, the top point *b* moves twice as fast as the center *c*, because it is twice as far from the center of rotation *a*. In general, the speed of any point of a rolling body is exactly proportional to its distance from the point of contact with the ground. The answer to the wagon-wheel question is now apparent. The top of the wheel is, at any given instant, moving twice as fast as the center, and therefore very many times as fast as a point near the bottom of the wheel. This fact may be confirmed by watching the wheel of a rapidly moving carriage; the upper spokes form a blurred maze, while the lower ones can be seen distinctly. That the top of a roller moves twice as fast as the center may be shown by a very old experiment. Take a plank and move it on top of a roller, as shown in Fig. 2. It will be found that when the plank has moved, say 10 feet, the center of the roller has moved just 5 feet, showing that the point in contact with the plank moves twice as fast as the center.

(138) (*a*) In designing a gas engine, in which diameter of piston is 2 inches, stroke $2\frac{1}{2}$ inches, clearance in cylinder equal to one-half the volume swept through by the piston, what should be the weight of the flywheel, 10 inches in diameter, to give proper compression? The speed must not fall below 200 revolutions per minute. Please give formulas and explain. (*b*) Would cast iron be suitable for the valve seats of this engine, or what is the best metal of which to make them? J. B., Bridgeton, N. J.

ANS.—(*a*) As you do not state whether the engine is of the two-cycle or the four-cycle type, we will assume the latter. The theoretical formula for the weight of the flywheel is as follows:

$$W = \frac{H g}{n^2 E V^2},$$

where W = weight of flywheel rim in pounds;
g = 32.16, acceleration due to gravity;
n = ratio between mean radius of flywheel rim and length of crank;
E = coefficient of unsteadiness, varies from $\frac{1}{20}$ to $\frac{1}{125}$;
V = mean velocity of crankpin, feet per second;
H = number of foot-pounds that must be stored up by flywheel per working stroke.

The work done on the piston during the working stroke will be about 25 foot-pounds. With a four-cycle engine, at least 80 per cent. of this must be stored to do the work of compression, and carry the engine through the other three strokes. We will therefore take $H = 20$ foot-pounds, and will assume $E = \frac{1}{30}$. From the given data,

$$n = 5 \div 1\frac{1}{4} = 4, \text{ and } V = \pi \times \frac{2\frac{1}{2}}{12} \times \frac{200}{60} = 2.18 \text{ ft. per sec.}$$

Substituting in the formula,

$$W = \frac{20 \times 32.16}{4^2 \times \frac{1}{30} \times 2.18^2} = 254 \text{ lb.}$$

You will readily see that this is an excessive weight for a 10-inch wheel. If you make the mean diameter 15 inches, $n = 6$, and the weight required will be $254 \text{ lb.} \times \frac{4^2}{6^2} = 113$ pounds; and, if the diameter is 20 inches, the weight will be $254 \text{ lb.} \times \frac{4^2}{8^2} = 63\frac{1}{2}$ pounds. It would, therefore, seem preferable to use a lighter wheel with a larger diameter. (*b*) Cast iron is the material ordinarily used.

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(139) How are mirrors made?
J. R., Woonsocket, R. I.

ANS.—See HOME STUDY MAGAZINE, October, 1898, Answers to Inquiries, No. 418.

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(140) (*a*) Referring to the enclosed sketch, Fig. 2, what is the diameter d of one of the five equal-sized balls that will just fill a cylinder 10 inches in diameter, that is, so that each ball will touch the wall of the cylinder and two other balls? (*b*) What is the diameter of a sixth ball that will touch each of the five balls, and also the plane upon which these balls are resting? F. W. K., Providence, R. I.

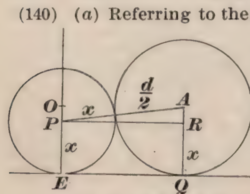

FIG. 1.

ANS.—(*a*) In the right triangle $A\,B\,O$, Fig. 2, the angle $A\,O\,B = a = \frac{1}{10} \times 360° = 36°$.

And $\sin a = \frac{A\,B}{O\,A} = \frac{d}{2\,b}$; therefore, $b = \frac{d}{2 \sin a}$.

Also, $b + \frac{d}{2} = O\,C = \frac{1}{2} D$,

where D denotes the diameter of the cylinder.

Therefore, $\frac{d}{2 \sin a} + \frac{d}{2} = \frac{D}{2}$;

whence, $d = \frac{D \sin a}{1 + \sin a}$. (1)

Also,

$$b = \frac{d}{2 \sin a} = \frac{D \sin a}{1 + \sin a} \div 2 \sin a = \frac{D}{2(1 + \sin a)}.$$

(*b*) Fig. 2 shows a section through the axis of the cylinder and the center of one of the balls. Let $x = P\,E$ = radius of sixth ball. Then, we have

$$P\,R = O\,A = b = \frac{D}{2(1 + \sin a)};$$

and $P\,A = x + \frac{d}{2}$, $A\,R = \frac{d}{2} x$.

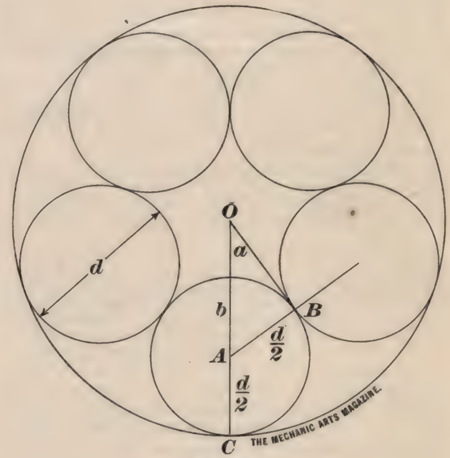

FIG. 2.

In the right triangle $A\,P\,R$, we have

$$\overline{A\,P}^2 = \overline{P\,R}^2 + \overline{A\,R}^2.$$

Or, $\left(x + \frac{d}{2}\right)^2 = b^2 + \left(\frac{d}{2} - x\right)^2$;

whence, $2\,d\,x = b^2$, which gives

$$x = \frac{b^2}{2\,d} = \frac{D^2}{4(1 + \sin a^2)} \div \frac{2\,D \sin a}{1 + \sin a} = \frac{D}{8 \sin a(1 + \sin a)}.$$

Hence, diameter of sixth ball is

$$2\,x = \frac{D}{4 \sin a(1 + \sin a)}. \quad (2)$$

In a table of natural sines we find $\sin a = \sin 36° = .58779$. Using this value of $\sin a$ and putting $D = 10$, we get $d = 3.702$, nearly, and $2\,x = 2.678$, nearly.

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(141) How will it affect the running of an Armington & Sims engine if the tensions of the springs of the governor are unequal? W. T. G., Providence, R. I.

ANS.—The different parts of the governor are connected in such a way that, theoretically, a difference in the tensions of the springs does not affect the running of the engine; the sum of the centrifugal forces of the two weights is resisted by the sum of the tensions of the two springs, the connections between the two weights forcing all to move together, so that the effect is the same as if but one weight and one spring were used, the centrifugal force and tension of the two being respectively equal to the sums of the centrifugal forces and tensions of the two weights and springs. Practically, an inequality in the tensions will increase the friction of the governor parts, and tend to make the governor less sensitive.

(142) (*a*) Is there any preparation that will dissolve the "scale" which forms on metal when brazing? I use a gasoline brazing furnace, with borax as a flux. (*b*) What is the lightest gauge of Shelby steel tubing $1\frac{1}{8}$ inches in diameter that can be safely used for the frame of a bicycle?
G. C. W., Conesus, N. Y.

ANS.—(*a*) Not that we know of. (*b*) It is impossible for us to say. The weight of tubing suitable for a bicycle frame is best determined by experiment; the history of the bicyle proves this. Manufacturers gradually reduced the weight until they found that they had gone too far, and bicycles were continually breaking down; then they increased the weight slightly. The stresses in a bicycle frame vary so much with the character of the road, weight of rider, and speed attained, that it is impossible by means of figuring to do more than corroborate what experiment teaches. In HOME STUDY MAGAZINE, July and August, 1898, there is an excellent article by Benj. F. La Rue, entitled "Stresses in a Bicycle Frame," that you should read.

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(143) (*a*) In a mine having three sections; with 50 miners in each section; cars to hold $1\frac{1}{2}$ tons; output, 750 tons per day; roads approximately level; what system of haulage will be most economical? (*b*) In a mine using electric haulage, with a voltage of 500, overcompound 10-per-cent. trolley system (600 volts considered fatal), what means would you use to protect persons from shocks, and what would be the result if a person came in contact with the live wire? These questions were given in an examination in 1897. (*c*) What is the meaning of the expression "overcompound?" H. M. McA., McCartney, Pa.

ANS.—(*a*) Electric or compressed-air locomotive haulage, particularly if electricity or compressed air is used about the mine for other purposes. (*b*) The wire should be placed on the rib side, near the roof, or sufficiently high to clear the heads of the men and mules while passing with cars. As an overcompound 10-per-cent. trolley system would never give a higher voltage than $500 + (500 \times .10) = 550$ volts, it would not, therefore, according to the above assumption, be fatal to any healthy person who came in contact with the live trolley wire. (*c*) "Overcompound" means that the generator or dynamo is so wound that the voltage between the terminals increases with an increase of load.

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(144) In my steam launch I have a water pump driven by a $4'' \times 6''$ engine running at 250 revolutions a minute; steam pressure, 100 pounds gauge. The pump has a 1-inch plunger and about $1\frac{1}{2}$-inch stroke; the supply and the feed pipes are $\frac{1}{2}$ inch. When the pressure gets above 50 pounds, the valves of the pump pound very hard. Please tell me how to remedy this. I may add that the pump supplies about the right quantity of water with the present stroke, but the stroke can be altered if desirable; the valves are standard check. R. S. D., Peterboro, Ont.

ANS.—It is probable that the trouble can be remedied by the use of larger check-valves. By using larger valves the lift will be less and they will return to their seats with little if any jar.

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(145) (*a*) How would you proceed to throw a cross-compound engine off the center? (*b*) How would you proceed to set the valves of a boiler-feed duplex steam pump? C. R. D., Lolo, Mont.

ANS.—(*a*) If there is no by-pass valve or other device, by means of which steam can be admitted directly to the low-pressure cylinder from the steam pipe, it will generally be possible, by using the starting bar, to work enough steam into the low-pressure cylinder through the high-pressure cylinder to start the engine. (*b*) There are several sizes and types of duplex pump, varying somewhat in detail; the following general rule, however, which applies equally well to any make of duplex pump, should be sufficient to enable you to set the valves on any size: set the valves so that, just before one piston comes to rest at the end of its stroke, the valve that regulates the admission of steam to the opposite piston will be completely shifted, thus starting that piston on its stroke. By this arrangement, one piston slows down and comes to rest, while its mate is beginning its stroke; the discharge of the pump is thus made nearly uniform, and there is little or no shock. The method of adjusting the valve for any particular pump is generally so obvious that no engineer should have any trouble in setting the valve so as to obtain the motion described.

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(146) (*a*) What is the effect of too much travel of an air-brake piston? (*b*) Has it anything to do with skidding the car wheels?
A. M. L., Fairmont, W.Va.

ANS.—(*a*) Increasing the travel of the air-cylinder piston increases the volume of the cylinder, and, as this increased space must be filled by the auxiliary pressure each time a train-line reduction is made, the brake will not set as hard for a given reduction as one that has a shorter travel. Also, increasing the travel decreases the pressure at which the brake cylinder and auxiliary reservoir equalize; hence, the brake will not hold as well as the shorter travel brake, on a full application, either. (*b*) A brake with a long piston travel does not apply as hard as a short-travel brake, and moreover releases earlier, and applies in full later than a short-travel brake; consequently, it has no tendency to skid the wheels. Short travel, on the other hand, is very liable to cause the wheels to skid.

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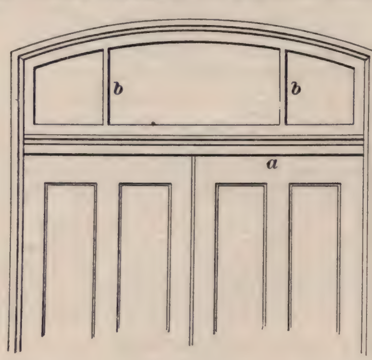
(147) (*a*) Do you know of any preparation that will keep leather belts soft? (*b*) What is the proper name for the bar between a door and the transom above? In the enclosed sketch, I have marked by the letter *a* the bar referred to. (*c*) What is the name of the bar in the transom window marked *b*?
J. T. P., Quincy, Ill.

ANS.—(*a*) There are many special preparations on the market. Castor oil is an efficient belt softener. Read "In the Workshop," in the April number of



THE MECHANIC ARTS MAGAZINE; it contains some useful practical hints about the care of belting. (*b*) The bar or mullion *a* is *itself* properly the transom. The sash above is called the *transom* sash because it rests on the transom. (*c*) The bars *b* are called *sash bars* or *astragals*.

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(148) Which of the following methods of forcing water into a tank requires the most power—up through the bottom of the tank, or up over the top of the tank? J. B. B., Cromwell, Conn.

ANS.—If you force water into the bottom of the tank

you will want a check-valve, which means extra work and expense. And, even when surrounded with a strainer, more or less fine dirt will get into it and cause leakage. More power will be required to put the water in over the top of the tank, for it all has to be lifted higher than the top, whereas, when entering the bottom, none of it has to be lifted that height. Speaking generally, however, one would at once say, put it in over the top. In any particular case, there might or might not be practical reasons against doing so, but it is better, where possible, to do so, for there is then no valve to keep tight.

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(149) (*a*) What is the horsepower of a Hamilton-Corliss condensing engine of the following dimensions: diameter of cylinder, 12 inches; stroke, 42 inches; revolutions per minute, 78; steam pressure, 80 pounds gauge? (*b*) What is the horsepower of the same engine non-condensing? Give method of computing the above. C. C. K., Leroy, Ill.

ANS.—(*a*) The general formula for calculating the indicated horsepower of a steam engine is

$$\text{I. H. P.} = \frac{PLAN}{33{,}000},$$

in which P = mean (average) effective pressure of steam in cylinder in lb. per sq. in.;
L = length of stroke in feet;
A = area of piston in square inches;
N = number of strokes per minute.

The mean effective pressure P may be found by means of an indicator diagram, or it may be calculated approximately when the steam pressure, back pressure, and cut-off, or its reciprocal, the ratio of expansion, are known. The formula for calculating the mean effective pressure (M. E. P.) is

$$\text{M. E. P.} = \frac{.9\,P\,(1 + 2.3 \log e)}{e} - .9\,p,$$

in which P = absolute steam pressure (= boiler pressure + 14.7 pounds);
e = ratio of expansion (= 1 ÷ real cut-off);
p = absolute back pressure.

For condensing engines with condensers in good order, p may be taken as 3 pounds per square inch, and 17 pounds for non-condensing engines. In order to apply this formula to your example, we must assume a value for e; assuming the horsepower to be rated on real cut-off of $\frac{1}{4}$, e becomes $1 \div \frac{1}{4} = 4$. Substituting this and the values given in your statement, we have, for the condensing engine,

$$\text{M. E. P.} = \frac{.9 \times 94.7\ (1 + 2.3 \times \log 4)}{4} - .9 \times 3$$
$$= 48 \text{ lb. per sq. in., nearly.}$$

The area of a 12-inch piston is $12^2 \times .7854 = 113.1$ square inches; substituting the known values in the formula for I. H. P., we have, for the condensing engine with $\frac{1}{4}$ cut-off,

$$\text{I. H. P.} = \frac{48 \times 3.5 \times 113.1 \times 156}{33{,}000} = 89.8 \text{ H.P.}$$

(*b*) Assuming 17 pounds per square inch as the back pressure, the mean effective pressure is

$$\text{M. E. P.} = \frac{.9 \times 94.7\ (1 + 2.3 \times \log 4)}{4} - .9 \times 17 = 35.5 \text{ lb.}$$

per sq. in.; and the indicated horsepower is

$$\text{I. H. P.} = \frac{35.5 \times 3.5 \times 113.1 \times 156}{33{,}000} = 66\tfrac{1}{2} \text{ H. P., nearly.}$$

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(150) In many machine shops, brown prints are used instead of blue prints; the paper is, I believe, called "brown-process paper." Can you tell me where I can get it, and about what it costs? I have been unable to purchase it at any of the stores here, and I think that perhaps I have called it by a wrong name. A. W., Providence, R. I.

ANS.—Process papers to produce dark lines upon a light ground can be obtained from any dealer that keeps a full line of architects' and engineers' supplies; the price is about 20 cents a square yard. Write to the Keuffel & Esser Co., New York, or to the Frost & Adams Co., of Boston. A description of the process and method of preparing the paper will be found in HOME STUDY MAGAZINE, November, 1898, article entitled, "The Duplication of Drawings."

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(151) How do you find the area of the shaded portion in the enclosed sketch, for any height x? R. K., Alameda, Cal.

ANS.—Let R = radius of circle;
D = diameter of circle (= $2R$);
n = number of degrees in the angle AOB;
A = the required area;
π = ratio of circumference to diameter.

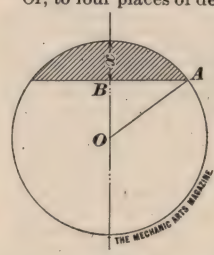
Then, we have

$$\cos n° = \frac{R - x}{R}; \qquad (1)$$

$$A = R^2 \left\{ \frac{\pi n}{180} - \sin 2n° \right\}; \qquad (2)$$

and approximately $\pi = 3.1415927$. (3)

Or, to four places of decimals, $\pi = 3.1416$.



Equation (1) determines n, and then equation (2) gives A the area of the segment exactly. When the segment is not very large, its area is more easily computed from the following very excellent approximate formula:

$$A = \tfrac{4}{3}\, x^2 \sqrt{\frac{D}{x} - .608}. \qquad (4)$$

If the radius is 100 inches, and the height x is 2 inches, the exact formula (2) gives $A = 53.16$ square inches; while formula (4) gives $A = 53.17$ square inches. If the radius is 100 inches and the height x is 50 inches, the exact formula (2) gives $A = 6{,}141.84$ square inches; while the approximate formula (4) gives $A = 6{,}139.13$ square inches. Using formula (4), to find the area of a semicircle whose radius is 100 inches, we get 15,753.65 square inches, whereas the correct area is 15,707.96 square inches.

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(152) What is the composition of the sticky stuff that is used on "Tanglefoot" fly paper, and how is it applied to the paper? J. W. M., Chicago, Ill.

ANS.—We believe that either of the following two recipes will answer the purpose: (1) Resin 8 parts, turpentine 4 parts, rapeseed oil 4 parts, and honey $\frac{1}{2}$ part. (2) Resin 1 pound, molasses $3\frac{1}{2}$ ounces, and linseed oil $3\frac{1}{2}$ ounces. Boil either one of the above mixtures until thick enough, and then coat the paper with it

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(153) (*a*) I have made a horseshoe from an old file, and now I want to know how to magnetize it. Kindly explain. (*b*) If it has to be wound, please explain the manner of winding, and how the wires should be attached to a dynamo. We have both arc and incandescent lights. L. T. M., Lakeland, Fla.

ANS.—(*a*) and (*b*) The steel must first be made glass-hard by heating to a cherry red and quenching in water. Then wind both limbs with several layers of insulated wire of about No. 18 size, first wrapping the steel with several layers of paper or cloth, to provide insulation. The winding over the two limbs must be in opposite directions, in order that one pole may become a north, the other a south, pole. Connect this winding in series with a 16-candlepower 110-volt incandescent lamp. Another method of magnetizing is to draw the steel across the poles of an electromagnet.

SELF HELP

CHARACTER IS CAPITAL.

CHARACTER is the poor man's capital. Great men have found no broad, rose-strewn royal road to their triumphs. Their road has been the old beaten road, by way of industry and perseverance. A constant struggle, a ceaseless battle to bring success from inhospitable surroundings, has been at all times the price of great achievements. The man who has not fought his way up to his own loaf, who does not bear the scar of desperate conflict, cannot know the meaning of success.

When James A. Garfield was elected United States Senator from Ohio, in January, 1880, President Hinsdale of Hiram College, Ohio, addressed the students in a speech appropriate to the occasion—when high honor had been done an alumnus of the college, a man who had been, in the course of his eventful career, first, bell ringer, and then President of the institution. President Hinsdale said among other things: "General Garfield once rang the school bell when a student here. That did not make him the man he is. Convince me that it did, and I will hang up a bell in every tree in the campus and set you all to ringing. Thomas Corwin, when a boy, drove a wagon, and became head of the treasury; Thomas Ewing boiled salt, and became a senator; Henry Clay rode a horse to the mill from the Slashes, and became the great commoner from the West. But it was not the wagon, nor the salt, nor the horse that made these men great. These are interesting facts in the lives of these illustrious men. They show that in our country it has been and still is possible for young men of ability, energy, and determined purpose to rise above lowly conditions and win places of usefulness and honor. Poverty may be a good school; straightened circumstances may develop power and character; but the principal conditions for success are in the man himself, and not his surroundings."

While the future President of the United States was yet an infant, his mother was left a widow. She was a woman of unusual energy, faith, and courage. Declaring that her children should not be separated, she kept them at home, together, till they were able to take care of themselves. Garfield's boyhood did not, as President Hinsdale well puts it, differ materially from the boyhood of other youths in his neighborhood. "He chopped wood, and so did they; he hoed, and so did they; he carried butter to the store in a little pail, and so did they. Other families that had not lost their heads naturally shot ahead of the Garfields in property, but such differences counted for less than they do now."

While still a mere lad, young Garfield's intense desire to earn a little money led him to become a boatman on the Ohio canal, which passed within easy distance of the Garfield farm. The humble duties of this trying and laborious position he discharged with so much fidelity and diligence that he was promoted to the loftier position of steersman of a barge.

We next find him a sailor, on one of the schooners plying Lake Erie, but illness compelling him to relinquish this mode of life, he returned home to tell his good mother of ambitious plans for the future. He had already acquired the foundation of an education in the ordinary branches of learning, and upon this foundation resolved to build a loftier structure than his surroundings would seem warranted in promising. With the very scanty saving within his reach, and by his mother's assistance, he began a course of study at an obscure institution, known as the Geauga Academy, not far from Orange, Ohio.

Too poor to pay their board in the village, young Garfield and his roommate rented an apartment in an old farm building not far from the academy, and there did their own cooking and housekeeping in the most primitive way. The future President had, however, a stout heart and a determined will. With honest and unremitting toil he applied himself to the task before him. He found work among the village carpenters, and spent his mornings, evenings, and Saturdays in their shops, where willing hands helped out the boy on his rugged path. By teaching a district school in winter he added a little to his scanty income. So for several

years, teaching in winter, working at odd times at the carpenter's bench, and attending the fall and spring terms of the academy, he secured the training necessary for a higher collegiate course. Tall, muscular, browned by wind and exposure, sound in every fiber of his body, a strong athlete, and a good student, this fair-haired country boy became a great favorite with his associates.

Admitted in the fall of 1854 to the junior class of Williams College, Williamstown, Mass., Garfield devoted himself with energy to his studies, and very soon acquired a reputation for scholarship far above that of any of his fellow students. He was graduated in 1856, carrying off the honors of his class in metaphysics, an enviable distinction.

Three years later, after having taken successful part in political campaigns in Northern Ohio, he was nominated by the Anti-Slavery party for State Senator, and elected by a substantial majority.

In the early years of the Civil War, Garfield won such distinction in the field as to entitle him to promotion, first as brigadier-general, and then as major-general. But while he was bravely fighting in the field, his fellow citizens of Ohio did not forget him. Elected to the National House of Representatives, Garfield, by the advice of President Lincoln and Secretary Stanton, resigned his major-generalship on the 5th of December, 1863, and two days later took his seat in the House of which he was so long to remain an honored member.

Garfield was, as already stated, elected in January, 1880, to fill the Senatorial chair, to to be relinquished on March 4, 1881, by that illustrious democrat, Allen G. Thurman. Before, however, General Garfield could qualify as Senator, he was, in 1880, by the Republican party of the nation, nominated and elected to the Presidency.

The universal acclaim of a proud and confiding people which greeted him on his accession to office, and the profound worldwide grief that marked his untimely taking off, it is needless here to recite. Garfield has left a noble name in American history. No man's career better illustrates the truth that "Character is the poor man's capital."

The best education in the world is that got by struggling to get a living. What is defeat?—Nothing but the first step to something better.—*Wendell Phillips.*

Men of character are the conscience of the society to which they belong.—*Emerson.*

RESOLUTE DETERMINATION.

"I CAN'T; it is impossible," said a lieutenant to Alexander. "Be gone!" shouted the conquering Macedonian, "there is nothing impossible to him who will try."

Were we called upon to express in one word the secret of so many failures among those who started out in life with high hopes, we should say, unhesitatingly, that they lacked will power. They could not half will. What is a man without a will? He is like an engine without steam—a mere sport of chance, tossed about hither and thither, always at the mercy of those who have wills. Strength of will is the test of a young man's possibilities. Can he will strongly enough, and hold whatever he undertakes with an iron grip? It is the iron grip that takes the strong hold on life.

What chance is there in this crowding, pushing, selfish world, where every one is pusher or pushed, for a young man with no will, no firm decision? "The truest wisdom," said Napoleon, "is a resolute determination." An iron will without principle might produce a Napoleon; but with character it would make a Wellington or a Grant, untarnished by ambition or avarice.

History is full of examples of men and women who have redeemed themselves from disgrace, poverty, and misfortune, by the firm resolution of an iron will. The consciousness of being looked upon as inferior, as incapable of accomplishing what others accomplish, the sensitiveness at being considered a dunce in school, has stung many a youth into a determination which has elevated him far above those who laughed at him, as in the case of Newton, of Adam Clark, of Sheridan, Wellington, Goldsmith, Dr. Chalmers, Curran, Disraeli, and hundreds of others. "Whatever you wish, that you are; for such is the force of the human will that whatever we wish to be, seriously and with a true intention, that we become." While this is not strictly true, yet there is a deal of truth in it.

It is men like Mirabeau, who "trampled upon impossibilities;" like Napoleon, who did not wait for opportunities, but made them; like Grant, who had only "unconditional surrender" for the enemy, who change the front of the world. "We have only what we make, and every good is locked by nature in a granite hand that sheer labor must unclench."

A man who can resolve vigorously upon a course of action, and turn neither to the

right nor to the left, though a paradise tempt him, who keeps his eye upon the goal, whatever distract him, is sure of success. Given a knowledge of one's will power, it would be comparatively easy to predict whether he would make of life a success or a failure. Men like Sir James Mackintosh, Coleridge, La Harpe, and many others who have dazzled the world, but who never accomplished a tithe of what they attempted; who were always raising expectations that they were about to perform wonderful deeds, but who accomplished nothing worthy of their abilities, have been deficient in will power. One talent with a will behind it will accomplish more than ten without it.

READINESS AND FIDELITY.

A GENTLEMAN who was being driven about the streets of a small but prosperous New England town made the remark, as his host pointed out a neat engine house with the apparatus all in readiness for instant use, that it would hardly pay to keep firemen in constant readiness for duty in so small a place, where a fire of any importance seldom broke out.

"We thought the same things ourselves, five years ago," replied his host. "We fancied we should get along if we had a good steam fire-engine and kept it near the center of the town, where our volunteer department, or any competent persons, could readily get at it in case of fire. We also kept a pair of horses for use with the engine at a nearby livery stable. For a time the arrangement worked beautifully, and the town saved money for the simple reason that there happened to be no fires worth mentioning. Then, all of a sudden, in the dead of a sharp winter night, a fire broke out in our lumber district, spread to the business section of the town, and swept everything before it, because it got such a tremendous start before met by any effective opposition. Nearly all the business part of the town was wiped out, and the loss mounted up into the hundreds of thousands. After that experience we did not want any more cheap fire protection; and long before our business section was rebuilt, we had in the city's employ a paid fire-department equal to any in the state. Within the past four years there have been three threatening fires in the lumber district, but our firemen were on the ground within seven minutes after the first stroke of the alarm, and not one of those fires, nor any other, has been able to get a dangerous start since we began to realize the value of readiness."

The lesson that this enterprising little city learned so effectively and obeyed so promptly is one equally important to every individual. The only real safety lies in sleepless and unremitting caution that presents to danger, moral or physical, a constant front of readiness. The happy-go-lucky method will never do either to build up character or ward off misfortune.

It is the initiative that counts. Once let a weakness get a foothold or a headway, and it becomes exceedingly difficult to dislodge it. We must smother it at the outset, conquer it before it gets a devouring hold of body and soul, just as the watchful, prompt, and trained fire department gets control of an incipient fire. The instant the alarm comes we must be ready to fight the aroused evil tendency, the wrong desire, the insidious temptation. Everything depends upon the promptness of our resistance to evil. Any dallying with it, any lingering to make deferred preparation, any moral confusion or hesitation arising from not being prepared, is destructive to character.

A great steamship was crossing the ocean. The mighty engines throbbed steadily day and night. The engineer and his assistants had never for a moment left their posts, although it had been days since any signal had come to them from the pilot house. Suddenly the great gong in the engine room sent forth its sharp clang. Stop! In an instant the steam was shut off and the machinery ceased its throbbing. Clang, Clang! Reverse the engines! The big levers are thrown over, the piston rods move, and the wheels revolve the other way. The mighty ship has escaped collision with an iceberg that suddenly looms up out of the fog, by the faithful readiness of those men in the engine room. What if they had left their places for just a minute in the seeming security of mid-ocean? What if obedience to that first, sudden, unexpected signal from the pilot house had been delayed for a single moment? How many precious lives might have been lost, how much treasure swallowed up by the insatiable sea, how much suffering inflicted upon hundreds of souls all over the world, how much human confidence destroyed! Think of the peril, all unseen, undreamed of, if the chief engineer had left his place for a minute, just before the gong had struck.

The value of fidelity is clearly illustrated by the career of Professor Morris, head of

the mechanical department, Cornell University. It is related of Professor Morris that one day he greeted an unexpected visitor in these terms :

"Ah, Mr. Depew, I am glad to see you, for I claim you as an old acquaintance."

"How's that?" queried Mr. Depew.

"I used to work for the New York Central," was the Professor's reply.

"Indeed ! In what department?"

"Oh, just in the ranks."

"How did you get on there?" asked Mr. Depew.

"I was just a fireman on an engine. That was a tough job, but it led up to the position of engineer. I made up my mind to get an education. I studied at night and fitted myself for Union College, running all the time with my locomotive. I procured books and attended, as far as possible, the lectures and recitations. I kept up with my class, and on the day of graduation I left my locomotive, washed up, put on gown and cap, delivered my thesis, and received my diploma; put gown and cap in the closet, put on my working shirt, got on my engine, and made my usual run that day."

"Then," said Depew, "I knew how he became Professor Morris. It was simply by doing each duty faithfully as he came to it, and preparing for the next."

BE MASTER OF THE SITUATION.

THE aim of education is a man capable of the largest amount of service to others and of the largest amount of personal happiness. Both of these elements in the end of education are determined by a knowledge of the civilization of the age and country in which the pupil is born and in which he is to live, together with a knowledge of the pupil himself, both mental and physical. The knowledge, power, and habits that would fit a child for a happy and useful life in one country would not in all respects fit him to live in another.

"The crowning fortune of a man," wrote Emerson, "is to be born to some pursuit which finds him in employment and happiness, whether it be to make baskets, or broadswords, or canals, or statues, or songs."

One of the most painful and pitiable objects in the world is a human being so fearfully and wonderfully made, carefully adapted to accomplish some particular good, and yet doing imperfectly and unhappily some other thing which Providence had adapted some one else to perform.

The world does not demand of any one in particular that he be a lawyer, a minister, a doctor, a farmer, or a merchant; it does not dictate what any one in particular shall do; but it does demand that he do *something* and that he be *master* in whatever he undertakes. The world will applaud the man who is master of the situation—for he is a king in his line. For him all doors shall fly open. But for the botch and the failure, the world has no mercy.

Sidney Smith declared: "Be what nature intended you for, and you will succeed; be anything else, and you will be ten thousand times worse than nothing."

THE MAN OF SIMPLE DUTY.

THE machinery had come to a standstill throughout a great mill. Instead of the steady whir of wheels, the sound of swiftly moving shafts, and the hum of belts, all was silent. Each workman raised from his bending posture, looked at his neighbor, and wondered what was wrong. It was not dinner time—the hands of the clock showed that. Work was not lacking—many orders were on the files. Machinists were not wanting—every one was at his post.

What, then, was the trouble? The foreman hastened down to the engine room.

"What's wrong, Joe?"

"Only a broken cog, sir. I heard a strange sound all at once; then there was a hitch as the wheel went round, and I saw that we must stop. It will take an hour to repair the damage. A new wheel must be put in."

An hour, during which all the shop must wait. An hour's delay in filling important orders. Some one would be disappointed in not receiving work promised on time. All because a cog had been broken.

* * *

An old man was sweeping the steps of a state building.

"Do you not get tired of this sweeping, day after day?"

"Why, no. Some one must do it. Why not I?"

He was a cog in the machinery.

* * *

In a great steel foundry it was the duty of one man to watch the seething kettle of white-hot metal, and as the dross rose to the top, to skim it quickly away. Nothing else. And yet the value of that metal depended upon the fidelity with which this man did his work. Pure steel must contain no dross.

* * *

A railway train runs into a depot. Hardly has it come to a standstill when the sharp

clang of the hammer is heard striking. one after another, the wheels under each ca If the ring is clear and unmistakable, the trained workman knows that all is right. On the other hand, if the sound be dull and cracked, he is sure that there is a broken wheel. It is his duty to report the fact at once. Life depends upon the manner in which he strikes those wheels.

* * *

Are such lives narrow, dwarfed, and weak? Civilization demands from every man, in every place, that he shall do his simple duty. "Only a cog in the wheel." What would the wheel be without those cogs?

"DO YOU WANT A JOB?"

SOME years ago, perhaps thirty or more, a little lad was loitering along the streets of an interior city. As he passed the shop of a local photographer, a man came out and spoke to him.

"Do you want a job?" he asked.

The boy said promptly, "Yes, sir."

"If you get it, will you attend to it?" the man asked.

Again the answer was, "Yes, sir."

"It is not a lively one. You have to sit still and watch things," the man said. "Do you think you can keep awake?"

"I can try, sir," the boy said, and after a little more talk he got the job.

It was not a lively one. He had to sit upon a housetop and watch a lot of photographic negatives to make certain that they got just enough light—not too much. He did the work well. The photographer never caught him napping, no matter how suddenly he came upon him. In a little while he showed that he was as intelligent as he was trusty. Then the photographer noticed that the lad's clothes, though worn, were always clean and neatly mended. A little inquiry proved that the new boy was the son of a widow who had very little besides her children. The little her son earned was a very material help to her. She was eager to have him in school. He had been there, all told, less than two months, but she could not send him any longer; he had neither the time nor the clothes for it.

Sitting aloft day after day, the lad fell to studying the heavens. Chance had thrown into his hands a volume on astronomy. At first he found it dry reading, but the study of it had, in a little while, redoubled his interest in his ever-beloved sky. He longed above everything for a telescope, to enable him the better to search out its glories and its mysteries. By the help of his kind employer he at length rigged up an apology for one—something whose limited powers served only to whet his appetite for real telescopic revelations.

He began to go to Sunday school. His teacher there grew interested in him and his ambition. Through her aid and counsel, joined to that of other friends, he went seriously to work to secure the coveted instrument. A second-hand one was offered to him for $200. He sent for it, but found it so unsatisfactory that he returned it. Expressage both ways cost him $20, which he could very ill spare. However, he got the money's worth in experience that determined him to be satisfied with nothing less than a telescope of the very first class.

To get money for such a one he worked and saved. A shabby coat had no terrors for him if the shabbiness meant something towards the desire of his heart. Pretty soon he was able to buy a telescope of the very best pattern, with a five-inch refractor. When it was duly in position upon the roof, where he had spent so many working hours, he was one of the happiest young fellows in the world.

His friends were almost as happy—particularly that friend who had given him the aerial job. The roof became a favorite resort for everybody in the city who had the least hankering after a sight of the stars. The young owner of the telescope was glad to let them look. As for himself, he nightly scoured the heavens, noting and recording by means of drawings the many wonderful things he saw there.

Besides a good telescope, he had phenomenally keen sight. That is evidenced by the fact that with this five-inch refractor, an instrument below the first power, he discovered and described a dozen comets. Providence had, perhaps, put it into the mind of a rich man to offer prizes for just such discoveries. They were not large prizes, but altogether this self-taught astronomer won enough to give him a welcome thousand dollars.

He had, however, rebuffs as well as helps from the big outside world. The American Association for the Advancement of Science met in his native city not long after he had begun his study of the heavens. He was presented to its president, Simon Newcomb, and began modestly to speak of what he had done and hoped to do.

"Humph! You had better put away that telescope! It is too big, anyway. You can

do nothing with it; you had better study mathematics than waste your time star gazing," said the great man. The beginner left him half heart broken. But after the first smart he resolved that he would study mathematics, and he did.

Time's whirligig brings some revenges that are precious. Fifteen years later Prof. Simon Newcomb writing to Prof. Edward Emerson Barnard, upon whom Vanderbilt University had conferred the degree of Doctor of Science, and whom the Royal Astronomical Society of London has been proud to make a Fellow, asked if Prof. Barnard "knew anything of a young fellow with a telescope, who had lived in Nashville when the Association for the Advancement of Science met there?" and added, after some further inquiry, "It cannot be possible that you are the one I mean?"

It was not only possible, but actual. Prof. Barnard, today the foremost of American astronomers, who has mastered not merely mathematics but the whole college course, who has discovered more comets than any other living man, and who has mapped and measured the fifth satellite of Jupiter, is the lad who made the beginning by faithfulness over few things upon the roof of a Nashville photograph gallery.

How true the saying of Lilian Whiting: "Success in life—the only success in its true sense—lies in its quality of living day by day, and not exclusively in its achievements, and still less in its acquirement of possessions. We can live in aspirations, in good will, in generosity, in love, amid the most limited, narrow, and trying circumstances." Success means fidelity to duty, with benevolent regard to our fellows.

What shall I do to be forever known?
Thy duty ever!
This did full many who sleep all unknown—
Oh, never, never!
Think'st thou, perchance, that they remain unknown
Whom thou know'st not?
By angel trumps in heaven their praise is blown,
Divine their lot.

THINKING DOES THE DEED.

BE IT known that that person is educating himself the best, other things being equal, whether in school or out, in law office, store, shop, or on farm, who is adhering with the most rigid exactitude to the mandates of his physical, mental, and moral needs in intense and persistent thinking. It is *thinking* that does the deed.

STUDY NECESSARY FOR SUCCESS.

MORE intellectual athletes are starting in the race of life, today, than ever before. The chances of success are diminished in proportion, for the supply is constantly encroaching on the relative demand. The members of the professions, the merchants, the mechanics, the farmers, who shall enter our places in the twentieth century, must be better men than we of the nineteenth, or they will fail. The law of the "survival of the fittest" will be applied to those of the twentieth century with more merciless severity than ever it has been to their predecessors. There is less room than ever before for "dead beats" and "bummers." Moral results are reached by railroad and telegraph in our time. The Greeks have told us that "the mills of the gods grind slow"; but they move faster as the world grows older. If in these our times one chooses to become a loiterer, sensualist, or sluggard, the mills will grind time to powder with a rapidity and thoroughness that the framers of the old Greek proverb never conceived.

If such is the necessity laid on us for growth and development, what are some of the conditions through which they are reached?

One important condition of growth is keenness and activity in observation of the phenomena of daily life. It is not enough that a man be mentally active in the calm of a library alone. He must think in the street and the shop, in the noisy court room and the crowded exchange. The successful student, as well as the man of affairs, must be constantly alive to what may not be inaptly called the molecular action of society. He must seize, classify, and formulate the results obtained, so that they may always be ready to inform the judgment and give precision, directness, and force to the action of the will. Thus also one makes his own the common sense and common judgment of the average man—always specially useful to one who is a student of progress in mechanical lines. This activity of observation must be formed into a habit and made a part of your very being.

The world generally gives its admiration, not to the man who does what nobody else ever attempts to do, but to the man who does best what multitudes do well.—*Macauley.*

The man who resolves to do one thing honorably and thoroughly, and sets about it at once, will attain usefulness and eminence.—*E. P. Roe.*

STUDENTS WHO HAVE BENEFITED THEMSELVES

THROUGH HOME STUDY

IN THE INTERNATIONAL CORRESPONDENCE SCHOOLS,

SCRANTON, PA.

ORE SORTER INSTALLS A MINE LIGHTING PLANT.

Having some practical knowledge of electricity, I enrolled in The International Correspondence Schools. The Course certainly gives a good, common-sense theory of the inner working of dynamos and electrical machinery in general. Since studying in the Course, I have helped install a lighting plant in the El Paso Gold King Mine, in Cripple Creek, at which place I am regularly employed as ore sorter. The Course, while simple, is very complete. I consider the mathematics alone worth ten times the amount charged for the Course.—*Chas. G. Bower* (*J. 1213*), *Cripple Creek, Colo.*

CHIEF ENGINEER OF A LARGE PLANT.

Any words or statements that I can make will fail to properly show my appreciation of the benefits derived from the Stationary Engineers' Course of The International Correspondence Schools. When I consider the fact that my early education consisted of just three terms of winter school in a country district, and the rest, previous to my Course with the Schools, what I picked up myself during leisure hours, and that I have had to earn my own living since I was 12 years of age, it is with a feeling of gratitude that I recall the poor, homeless boy, kicked about from pillar to post, who has now become chief engineer of one of the largest mills in the South, through the Schools and their splendid method of teaching.—*A. H. Strong* (*H. 74*), *Charlotte, N. C.*

TELEPHONE MANAGER GREATLY BENEFITED.

I cannot say enough in praise of The International Correspondence Schools and what they have done for me. The Course has been full of pleasant surprises to me, as I have found it far better than I had expected from the description in the Circular of Information.

For the benefit of my skeptical friends, I would say that they can not only learn a great many new things from the Schools but they will also find out how little they really know regarding matters on which they thought themselves well informed. I wish to thank the Schools for their attention to my personal needs. The knowledge I have obtained through the Course has been of great practical benefit to me in my position as manager of the Painsville Telephone Company.—*E. T. Grauel* (*M. E. 6163*), *Painsville, O.*

APPRENTICE STEAM FITTER BECOMES A SALESMAN.

I have derived great benefit from my Course in the Schools. The interest taken in the scholars seems almost incredible, when the enormous amount of correspondence handled by the Schools is taken into consideration. I began work as a helper in a steam fitting shop. The knowledge gained through the Course in Plumbing, Heating, and Ventilation has qualified me for the position I now hold as salesman with one of the largest manufacturers of plumbing and heating goods in Chicago.—*R. E. Dewey* (*P. 33*), *Rockford, Ill.*

DRAYMAN BECOMES MANAGER AND DRAFTSMAN.

I have had a hard struggle to obtain an education, as I was obliged to go to work when quite young. Being very ambitious to advance myself, I bought textbooks and studied at night. I first learned the carpenter's trade; then served a three-year apprenticeship at the plasterer's trade; and finally took a position as drayman and clerk in a lumber yard. A year ago I enrolled in the Schools, and made more progress in that year than in five years previous, and at much less cost. I am now manager of the yard and my salary is doubled. I also make all the plans used in this city, including residences and store buildings ranging in value from $700 to $4,000. The system of the Schools is all right for any one with push and energy.—*D. C. Fairfield (A. 1799), Unionville, Mo.*

FROM MINER TO MINE SUPERINTENDENT.

I can heartily recommend the system of instruction of the Schools to any one who can read and write and wishes to better his position and salary through study and perseverance. I enrolled in The International Correspondence Schools on the 16th of October, 1891, being their first student in the Complete Coal Mining Course. At that time I was driving headings in a mine. Ten months later I received a state certificate as foreman, and secured a position as assistant mine foreman. This I held for one and one-half years, when I obtained a position as mine foreman, and six months later was given charge of both the inside and outside of the mine where I was employed. This position I have held nearly four years, my salary having been increased 40 per cent. since I began my Course.—*Thomas Coates (C. M. 1), Yatesville, Pa.*

SCHOOLBOY BECOMES A DRAFTSMAN.

I have been very much pleased at the practical results of my Course in Mechanical Drawing in The International Correspondence Schools. After graduating from the high school at home, I asked the principal of the school where any one who was unable to go to college could obtain a knowledge of mechanical drawing. He said he considered the "Scranton School Courses" the best way of obtaining it. I accordingly enrolled on the 31st day of July, 1897, and received my Certificate of Proficiency in less than six months. I was able to obtain a position by merely showing the drawings made in my Course. I have since enrolled in the Complete Mechanical Course and am making good progress in the same. The knowledge of mechanical engineering thus gained, combined with my work as draftsman, is certain to bring advancement.—*Carl W. Gage (M. D. 1014), Groton, N. Y.*

IS NOW IN ELECTRICAL BUSINESS FOR HIMSELF.

I cannot speak too highly of the merits of the system of education of The International Correspondence Schools.

My connection with the institution has been of very great benefit to me. I enrolled in the Wiring and Bellwork Course on the 31st of January, 1898. By studying in spare time I completed my Course and received a Certificate of Proficiency on the 21st of September, 1898.

I am now in business for myself, being a member of the Carlisle Cycle Company. We deal in bicycles, sporting, and electrical goods, and do a general wiring and repair business.—*John S. Gingrich (J. B. 23), Carlisle, Pa.*